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JOURNAL OF FORESTRY

VOL. 35 SEPTEMBER, 1937 No. 9

The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it. Editorials are by the Editor-in-Chief unless otherwise indicated and do not necessarily represent the opinion of the Society as a whole.

EDITORIAL

"THE MIRROR OF THE PROFESSION"

OF late years we have fallen into a deep discontent with the JOURNAL OF FORESTRY. In the main, this has been an honorable discontent engendered by our devotion to the JOURNAL, the highest development of which has become our major concern. The criticism of the JOURNAL OF FORESTRY has been neither carping nor frivolous. It has been constructive, serious, and honest. The fact that members of the Society are critical of its journal is an indication of professional growth and development. The JOURNAL OF FORESTRY is truly the mirror of the profession and we are becoming increasingly conscious and concerned with that which is held before it.

Editing the JOURNAL OF FORESTRY is not an easy task. It is indeed a far more difficult task than editing a strictly scientific journal. The members of the Society do not have a common major interest as do the members of many scientific societies. Some of the members of the Society are primarily interested in silviculture, some in its scientific foundations; some members are primarily interested in the social and economic implications of forestry; some in the problems of forest education; some in forest taxation; some in forest mensuration; some in game management; some in forest utilization; some in forest protection; some in forest pathology; some in forest entomology; some in soil erosion and conservation; some in grazing; some in forest influences; and a very large number in administrative procedures and problems. Precisely what percentage of the members of the Society belong to each of the above mentioned groups is not known or is it very important, but it appears reasonable to assume that the last group, namely those interested in administrative problems is by far the largest group and that it includes most of the younger members of the Society.

In order to have a JOURNAL properly balanced with the interests of the members of the Society it would be necessary for the editor first to know the major interest of the members of the Society and, secondly, to have available a sufficient number of manuscripts in each of these fields to be able to satisfy more adequately these varied interests. If the editor of the JOURNAL knew precisely what the Society wanted, and if he had the necessary manuscripts, which of course come from the individual members of the Society, it would not be so difficult a task to meet the immediate demands of the Society.

But even under these almost Utopian conditions the editor of the JOURNAL would still face other important problems. The mirror of the profession is viewed not alone by foresters but by the members of other professions and scientific disciplines

as well. The opinions and attitudes of other professional and scientific workers are conditioned to a considerable extent by the contents of the Journal of Forestry. The regard and esteem with which forestry is held by other professional and scientific workers is a matter of vital concern to every forester. The general recognition and acceptance of forestry among the professions is indeed the deepest and noblest aspiration of all foresters. The members of the Society must, therefore, be willing and ready to make certain concessions in the Journal in order to build up the scientific and professional prestige of forestry.

There is at least one other important problem involved in editing the Journal of Forestry. The Journal of Forestry is one of the most effective instrumentalities for raising the professional level and tone of the Society. The Journal must lead rather than follow. It must elevate and not lower the professional and scientific tastes of the Society. It must stimulate the Society to a higher plane of professional thinking and activity. It should challenge the intellectual capacity of its readers. In short, the Journal of Forestry is the means by which the Society lifts itself by its own bootstraps.

In order to obtain a realistic picture of the reasons for the contents of the Journal of Forestry it is necessary to recognize that the preparation of manuscripts for publication is the major activity of a comparatively small group of members of the Society—the regional forest experiment station workers. It is also an important activity of the members of staff of the forest schools. Contributions from men in administrative work must be prepared quite largely on their own time. Consequently, despite the fact that the forest experiment station workers and members of forest schools comprise only a comparatively small percentage of the total number of members of the Society the number of contributions from them is disproportionately large. With this condition there can be no legitimate criticism. These men do, or at least should blaze the trail of professional and scientific progress. Nevertheless, there is no reason why such a large proportion of the members of the Society should be inarticulate. A much larger number of contributions from men in administrative work dealing with the important problems and details confronting forest administrators is greatly to be desired. Still more to be desired is an increased interest to contribute to the Journal among the younger members of the Society. The development of this interest is indeed one of the important responsibilities of the editorial staff.

The development and promotion of the Journal of Forestry is a joint responsibility of the entire membership of the Society. If the Journal falls short of what competent critics feel it should be, then the profession has fallen short. If, on the other hand, competent critics regard the Journal as a serious, technical and scientific periodical, the credit for this belongs to the members of the Society. It is greatly to be hoped that the Society will always be critical of its journal, that it will never be satisfied with anything but the best the profession as a whole is able to produce. The Journal of Forestry and the Society have a common destiny. The one merely reflects the image of the other. The Society which stands before the mirror is not a static thing. It may improve or it may deteriorate. It may grow or shrink in stature. Its intellectual and professional roots may grow deeper or become superficial. All of these changes will be reflected in the mirror of the profession.

TECHNICAL REQUIREMENTS FOR A FORESTER IN THE FEDERAL SERVICE

By ELERS KOCH

U. S. Forest Service

Problems dealing with the education and the personal qualifications of a forester have received considerable attention in recent issues of the JOURNAL. This is both fitting and proper because no other single factor will so greatly affect the future progress of forestry in America as the training and abilities of men who are in, or preparing themselves for the profession. Mr. Koch properly maintains that forestry, irrespective of the governmental department in which it is practiced, is largely land management and that the proper management of forest lands requires a corps of men of professional, subprofessional, and nonprofessional grades. The educational requirements of the professional foresters are discussed in detail and it is concluded that the ultimate success of the individual depends not alone on his training but to a great extent on his intelligence and character.

IF I were inclined to be a stickler for exact definitions I would start by attempting to define the term "forester", and then devote the remainder of the discussion trying to determine who is and who is not a forester.

For the purpose of our discussion it is not necessary to split hairs on definitions. I propose to discuss the personality, background, education, training, and experience of the kind of man that is needed to fill the general requirements for administrative and technical personnel in the Forest Service and other federal agencies having similar functions in the management of forest land.

The fundamental sciences back of wild land management do not vary greatly, whether the land be managed chiefly for recreational purposes, for timber growing, for forage production, or for water flow regulation. These major functions are in most cases so inextricably mingled that any system of management of wild land must generally consider them all, with due regard to specialization in the major ones on a particular tract.

It should be recognized from the start that all employees of the Forest Service are not foresters, and do not need to be foresters. Besides the office force of clerks, accountants, draftsmen, etc., the Forest Service requires a goodly number of specialists in nonforestry lines—road engineers, construction engineers, architects, landscape engineers, entomologists, pathologists, lawyers, editors, and the like.

In addition to these there is a large subprofessional force of the foreman type—construction foremen and superintendents, fire foremen, foremen of crews engaged in planting or timber cultural work, scalers, and the like. In the past, most of these men have been temporary employees, but there is now a movement to carry on the permanent rolls a larger percentage of these men, recognizing that they are not technical foresters or land managers, but a useful and necessary adjunct to forestry and land management.

Many of the arguments and differences of viewpoint relative to the requirements and training of foresters are due to failure to recognize this obvious fact, that the practice of forestry and the management of forest lands require a supplemental force of nonforestry technicians and subprofessional supervisory personnel to carry out the engineering and other works which are a means to the practice of forestry. Such supplemental professions and trades should be supplied by drawing on men trained in those lines, rather than to expect forestry training to

be broad enough to cover them all, from plumbing to bridge building.

The Forest Service has had so much engineering work to be done that I have even heard it proposed by a Forest Service man in an influential position that an engineering school training would be more valuable to the average Forest officer than a forest school training. That is an expediency viewpoint that should be squashed. As valuable and essential as engineers are in their field, the background for a forest land management job must include much other than pure engineering.

I cannot emphasize this point too strongly, that there are several different kinds of jobs in government forest work, some of which call for professional training in forestry, some for training in engineering and other technical professions, and some which do not require professional training at all. As a rule the best type of man for a foreman, who is actually leading and directing a group of men on a job, is not the college-trained man, but rather the type of man who has been brought up from boyhood in close contact with outdoor work, who knows from intimate experience the reactions of working men, and who is at home with woods tools and machines.

This distinction is recognized in most lines of work. Any construction job, for instance, requires a technical force of engineers, architects, and the like, who plan and generally direct the work, but equally important are the foremen who have learned their partciular angle of the job from years of actual experience. The two jobs are not interchangeable.

Just so in the Forest Service. We need, in addition to the professional force, what may be called a subprofessional group who can act as fire foremen, foremen of construction crews, and who also can do, under skilled direction, some of the more distinctly forestry work, such as scaling, direction of slash disposal, and even much of the timber marketing, planting, an stand improvement work, after the princ ples and specifications have been dete mined by forestry experts. This type man should be definitely provided fo in the permanent personnel, and classifie under Civil Service procedure. Their jol should have been learned through lon experience and training on the job rath than by college training, and they woul not ordinarily be eligible for appointme in the professional grades, although the are always among this class of men o casional outstanding individuals who, b special ability and self-education, may b able to pass into the upper grades. A rath rough comparison would be the noncon missioned and commissioned officers in th Army. The Forest Service in past yea has been so ultra-democratic as to refu to recognize this distinction in classific tion, but recognized it must be, with n disparagement of the fine men in the no professional grade.

In the past the district ranger ofte was the type of man who belongs in th subprofessional grade, and his work w largely of that type. Generally speakin this is no longer true. With the pione days about over, and conceptions of fo est use expanding, the district rang position has become an important one land management. It is true that the are still many engineering jobs to d roads, trails, and bridges to construct a maintain, towers and buildings to co struct, and telephone lines to put u These things are only means to an en and the district ranger's job becom primarily one of managing, developi and using the resources produced in h district, the preparation of plans for ti ber use, grazing use, recreational u game and fish management, fire contr and the administration of all these u and activities. He is able to call in en neering specialists for technical jobs b yond his range, and he has a force practical, skilled men under him to car

out his plans on the ground. It is distinctly the job for a technically trained forester.

Now, having disposed of the proposition that all employees on a forest management unit do not need to be technically trained foresters, let us get back to our major subject of the background and training of the forester. While there are many lines of specialization within the field recognized as forestry, there are two distinct lines which may require something different in the way of basic training and qualifications. The first of these is the administrative or land management line, which would include most of the rangers, assistant supervisors, supervisors, some staff specialists, and the administrative force up through the Regional and Washington offices. The other is the research line. There has been, and I hope will continue to be, some interchange and transfer between these two lines, but I believe the young man in training for forestry would do well to make his choice between them and vary his basic training to fit.

At the present time it is practically impossible for a young man to get a foothold which will lead to the upper grades in the permanent National Forest administration without passing a technical Civil Service examination, which almost necessitates at least a four-year forest school course. This is as it should be; granted that there are in the Forest Service some extremely competent and valuable men who came up through the ranks and never saw the inside of a forest school—some of them nothing beyond high school, or even less. The old ranger and supervisor examinations yielded some good men, who had only to demonstrate that they could ride, pack, chop, shoot, and run a compass line, but they also brought in a great many men who have been left behind in the march of progress. With a surplus of young men knocking at our door, with both technical training and some practical experience, it seems hardly worth while to argue for modifying the entrance requirements in the permanent forestry organization to include men lacking technical training. This, of course, does not preclude permanent employment of specialists in other lines, or men in subprofessional grades.

The field of forestry, including all wild land management, is so broad that there is practically no subject taught in the universities which would not add something to a forester's effectiveness and breadth of view. However, man's time on this earth is short, and the best we can expect for the mill run of our candidates is that they will come out of school with the general aspect and point of view of an educated man, knowing how to read and to reason, and to expand the elements of scientific and technical knowledge obtained at school by use and study. We can expect that they will have a fair introduction to the natural sciences—the more the better. They will have enough engineering to make and read maps and make simple surveys, but we do not expect them to be fully trained engineers. They will, of course, have technical courses in silviculture, forest mensuration, forest management, range management, etc., as much as they can cram into a four or five-year course, and there will be many things they would like to get that they will have to leave out. A training in these technical courses is required to qualify a man as a forester, under any reasonable definition. He may have all the supporting sciences—botany, ecology, geology, zoology, entomology, chemistry, sociology, and economics—but without a knowledge of silviculture, forest management, and forest mensuration he is not a professional forester any more than a mathematician is an engineer.

The ideal collegiate training would be a six-year course in which technical forestry subjects, including engineering, appeared principally in the last two years,

and four undergraduate years were devoted to a good general educational course with emphasis on natural sciences and mathematics, but with a good grounding in English, economics, history, and similar subjects tending to broaden the student's viewpoint and give him the habit of thinking and reading in varied lines. This is, of course, the general scheme of such graduate forest schools as Yale. Men so educated should have a considerable advantage over the much narrower education possible in a four-year course. I believe the future trend will be in that direction.

After school, what? There are a lot of things the forest school graduate will eventually have to know that he will not learn in school. How is he going to learn how to put his theory in practice so that he can do or direct such jobs as cruising and appraising a block of timber, scaling logs, appraising and mapping the fire hazard types in a district, planning an adequate road system, making a timber or range management plan, or planning and organizing fire control on a protection unit, or even the more humble jobs of grinding an axe, hooking a chain on a log, connecting a telephone set, or packing a mule. A forest school graduate is no more a competent practicing forester than a medical student is a physician before he has had his experience as a hospital interne.

Practical experience under proper direction is the only answer. And here we have the phase of the young forester's training which has been the most neglected. Most of the forest schools have a reasonably standardized curriculum, which can perhaps be improved somewhat, but generally meets the requirements. Nothing but chance and the opportunity to get a job of some sort has governed the young man's field experience for the most part.

The Forest Service has been expanding and taking on new jobs so rapidly that, perhaps of necessity, its personnel poli has been a haphazard grab bag. It is be hoped that it is now getting sufficient stabilized so that a more systematic p icy of recruiting and training new m can be achieved. Any large unit of c ganization should know approximate the annual turnover of its personnel, a should plan to take on for traini enough young men to fill the requi ments. These men will naturally co from the junior forester and range e aminer Civil Service lists. The pr cedure is liberal enough to allow a co siderable degree of selection from the lists.

Aside from some specialist lines, t training of the majority of these m should be directed to lead to the distr ranger position, the first permanent ru in the ladder of advancement in la management positions in the Forest Se ice, and through which practically all our future foresters in management po tions will go.

The young forest school graduate, most cases, will have had at least tw summers of field experience—usually whatever job he has been able to get. wise personnel policy would lead to t sizing up of each man, determination his past experience, and planned allo tion to jobs which will round out h training. The experience to qualify f a district ranger's job would vary by R gions. In this Region, as an examp training should include timber survey range survey work under expert sup vision; timber sales work, including bo marking and scaling; improvement wo which will teach the use and handling tools and woods equipment; experience fire control jobs, both as lookout a fireman; and, of course, as much fi fighting and other fire control work can be gotten in. It will not always possible for every man to get assignme to every line of work, but if possib such special lines as planting, blister r

control, insect control, game patrol, recreational plans, etc., should be included. The training should be rounded out by assignment to a ranger district for at least six months as an assistant to the district ranger in all lines as the work occurs. The minimum time to qualify an average forest school graduate as a district ranger would be one full year plus two previous field seasons.

After service as a district ranger, future lines of promotion and assignment may vary with the capacity and trend of ability of the individual. Some men may stay permanently in the ranger grade. The usual line of advancement would be through assistant supervisor, supervisor, and the various grades in the Regional and Washington offices. Specialists in various forestry and land management lines may be developed by special assignments and further study.

Where do range management men come into this picture? The answer is, that for service in the National Forests or other similar land management agencies, there is no place for foresters who know nothing of range management, or for range managers who know nothing of forestry. The basic scientific training for any job of wild land management is the same. Naturally, the men who are going up for the junior range examiner examination will specialize in range management subjects their last year or two in school, while the junior forester candidates will specialize in the more advanced technical forestry subjects. Field training on a management unit where grazing is important will naturally vary somewhat from that on a unit which is chiefly concerned with timber growing.

The same thing is more or less true of game management specialists. At the present time there are few men in this country specifically trained in game management, but, recognizing the fact that men in this line of work will have to learn most of their stuff on the job, I should be inclined to pick a man of technical forestry training and experience rather than a zoologist or biologist. The job of game management is only another phase of land management, and the relation of the game to the growing crops on the land, forest, and forage, is the most important phase of game management. Consequently, the game manager should first of all understand forestry and range management, with a supplemental knowledge of zoology. Certain specialists will be required for such branches as investigation in stomach parasites and other diseases of animals and similar technical lines, but these specialists do not have the best training for the broader phases of the job.

So far I have had in mind primarily the classes of men for employment in the Forest Service. The Indian Forest Department, of course, has a similar problem. But how about the National Park Service and the Soil Conservation Service—have they any use for technically trained foresters?

The Park Service is managing tracts of timbered land, many of them very similar to adjacent National Forests. Its object of management is different, and at present timber as a crop does not enter the picture, nor does grazing of domestic stock. Otherwise the problems are quite similar. The Park Service undoubtedly requires several different kinds of professional specialists, just as the Forest Service does, but it could use foresters to advantage, although a special course could be devised for National Park Service, which might include less forestry and more of some other sciences.

The Soil Conservation Service requires some foresters for true forestry work, since its field includes farm woodlot forestry. This Service has employed some foresters on jobs not distinctively forestry; largely, I suppose, because most foresters have some knowledge of soil conservation work and of the related sci-

ences, and the job is a new one lacking a specially trained force. Fundamentally, most of the Soil Conservation work is not forestry.

The discussion so far has pertained primarily to the class of men engaged in land management. There is also a very large group of forseters in government service engaged in research, on many varied and specialized lines, some of which are pure forestry, others allied to forestry. Some of these fields are silviculture, forest products with its many ramification, forest mensuration, forest pathology, forest economics, erosion, range management, wild life management, recreational use. All of these subjects are further subdivided into many special lines. Most of them require a man grounded in the fundamentals of forestry, though some lines are so specialized as to call for primarily an engineer, a chemist, or a biologist. As I said before, I am not going to quarrel over just what is forestry or a forester. It is obvious that research in all these varied lines pertaining to forest management cannot be covered by a single line of education and training.

In times past a large percentage of the research personnel has been recruited from the junior forester list. It seems probable that this stage is passing and that in the future, research personnel will have to have more advanced education in specialized lines up to a Master's, or perhaps a Ph.D. degree.

I have left to the last a consideration of what is the most important requirement for a forester, and that is the quality of the men themselves. At the risk of being classed as an oldtimer, who looks into the past and thinks nothing new is as good as it used to be, I am going to venture the statement that the personal quality of the men who graduated from the forest schools in the first five or six years of the rise of forestry in the United States averaged considerably above the mill run of the present-day graduate These men were drawn into the new pro fession by the magnetic influence of Pi chot, Graves, Fernow, Roth, and Schenc and in some way they tapped a high stratum of American youth than the pre ent-day forest schools are drawing fro This statement refers to averages, not individuals. There are doubtless ma men of the very highest type now in th forest schools.

Studies by Professors Graves and Gui in 1932 indicated that the intelligence tes of forestry students in most universiti fall below the all-university median, a that in all cases the forestry median w lower in the scale than engineering, p medicine, pre-law, science, liberal ar commerce, and chemistry. This is a sitı tion that the forest schools could a should correct, by upholding entran standards and jealously maintaining t dignity and character of the forestry p fession.

I have sat in on many conferences f selection of a man for promotion to vacancy in the Forest Service, and alm invariably the selection of the man hing upon the personal qualifications and e perience of the candidate rather than t quality of his technical training. Th two essentials are intelligence and cha acter. By intelligence I mean the qual of the brain, the ability to learn, to re son, and to use judgment. Character a broad term, but the essential qualit are confidence, courage, and leadersh Since much of the work of a forester in the field, it is essential that the f ester possess a certain ruggedness spirit and body which will enable him meet with equanimity and to enjoy t discomforts and occasional hardships woods life, and to demand the respect the tough men of the woods he must co mand and associate with. This does n mean that he should be a "roughneck a man who "can chew tobacco and s against the wind". We might rememb

that, of the intrepid men who attained the greatest height on the two most terrible mountains of the Himalayas, one was a poet and one a musician. A forester who attains the higher positions in the profession must combine the ruggedness of the woodsman with the finer qualities and educated perceptions of a man who is at ease in the councils of the learned as well as in the logging camp. The selection, recruiting, and subsequent training of such men are of far greater importance to the federal Services than any possible modification in the forest school curriculum.

SECRETARY WALLACE has recently transferred control of the Forest Products Association (Farmers' Cooperative) from the Resettlement Administration to the Forest Service, in order that its activities may have the benefit of the technical knowledge of the latter agency. Frank A. Altonen of Quincy, Mass., who has been placed in charge of the organization, states that the enterprise will now be operated as a business and extended to a large number of timberland and woodlot owners, sawmill and paper plant operators in New England.

CATCHWORDS AND FADS IN FORESTRY

By JOHN F. GODFREY

Yale School of Forestry

This article represents the comments upon, and a free translation of, a similarly titled article written by Dr. Leopold Hufnagl[1] and appearing in the Osterreichische Vierteljahresschrift für Forstwesen, 1935.

"MANAGEMENT is based on experience; natural sciences only follow and attempt to explain the causes of the phenomena."

Thus, Dr. Hufnagl launches upon a theme in which he admonishes the profession that due to the great variety in soil conditions, climate, and needs and demands of the individual species, rules of management which can be universally applied regardless of local conditions and variations do not exist. Since regulated forest management first began, many theoretical concepts have appeared in the field, apparently broad enough for general application but, upon closer examination, found to be only passing or possibly locally applicable catchwords and slogans. To accept blindly such theoretical speculations based, at the best, on local experience alone, for unrestrained practical application is to assume a serious responsibility because irreparable damage to forest stands can result through their application with species and on sites not suited to them.

Hufnagl then proceeds to analyze a dozen or so of the more prominent of such catchwords and fads as they have appeared in forestry literature since the turn of the century, and in each case points to the reasons which should keep foresters from accepting them as universally applicable methods and guides. Several of them might prove of interest to American practitioners and are for that reason presented below.

To begin with, the rigid, unmodifie adherence to area regulation in fore management is severely criticized. Man sacrifices in total yield have been force on forest stands by completely ignorin the existing abnormalities of age class di tribution by more or less geometricall dividing a forest area into squares of a nearly the same size as possible and cu ting them at predetermined periods. I spite of the fact that due to cutting man stands before maturity and permittin others to stagnate into overmaturity, hug losses in increment are brought abou this damaging procedure is at present sti widely applied in Germany.

Wagner's strip shelterwood metho highly recommended and much discusse as it may be in forestry literature designated as being but a dangerous theoretical fad proposing through its princ ples to add to the irretrievable losses a ready incurred by the strict applicatio of area regulation. The only notabl differences between the two fads are th cutting direction (which in this case advocated to be from north to south in stead of east to west) and the surround ing of the squares or compartments on a sides with windbreaks. Fortunately th fallacies of this method are believed t have been sensed in actual practice.

Compartment management brought wit it a general spread of clear-cutting an the creation of pure even-aged stand

[1]Hufnagl, Leopold. Schlagwörter und Moden in der Forstwirtschaft. Osterreichische Vierte jahresschrift für Forstwesen 53: 177-186. 1935.

This wave of propaganda created the possibility of setting up yield tables, summing up the laws of growth into figures and thus armed permit its advocates to threaten forests with mathematics. As a result the much-discussed financial rotation was born. Had foresters, with few exceptions, not wisely refrained from wholeheartedly applying the fundamentals of this catch phrase much additional damage to forest stands would have resulted. In fact, if this theory had been widely applied in the field, the author ventures the belief that Central European forests today would as a result be stocked with pole sized material only—with not a stick of it over eighty years old.

So far in the discussion, the author may have had most of his American readers in accordance with his statements. However, when he proceeds to include seed origin in his list of dangerous fads and catchwords a considerable amount of frowning among American foresters can be visioned. Hufnagl reasons that since at present we cannot definitely attach any significance to the origin of seeds we should not help to increase their cost by encouraging measures leading to regulated purchase and sale of forest tree seeds. It is Hufnagl's firm belief that any notable abnormalities in tree growth or form which have occurred in the past and which were promptly blamed to unsuitable seed origin could have been positively avoided by proper treatment and cultivation of the species in question. For instance, species which do not develop a straight stem when grown in the open simply must be raised in dense stands, then they will develop straight stems. Reference is thereupon made to personal observations over a period of several years in densely grown sixty-year-old spruce stands and these are then rather dogmatically compared with more open-grown stands. It seems that here the author conveys a rather definite contradiction to one of his introductory remarks in which he stated that a sound management rule is based on locally existing conditions, never on one condition alone.

The widely heralded and highly recommended Dauerwald form of management has not been overlooked in this exposition. The amazingly high yield figures originally given for the Bärenthoren tract have been found, upon closer inspection, to have been considerably exaggerated. When eventually the true yield figures were compared with those of neighboring forests existing under similar site and climatic conditions, it was found that the yield here was just as commendable though management was on an altogether different basis. To uphold the Dauerwald form of management as a universally ideal one therefore would be totally unfounded. At its best this form of management only represents the expression of an old idea locally applied, viz., a closer adaptation of silvicultural measures to the laws of nature.

Hufnagl next directs his comments to the term "selection forest." When a continuous forest is defined as a selection forest in a recently published technical treatise it merely emphasizes the fact that the term "selection forest" has again (as several times before) been wrongly interpreted and popularized to the detriment of forestry. The term has deteriorated to a meaningless catchword suggesting all things to all men. The usual definition of selection forest is also incorrect and misleading. Odd as it may sound a selection forest, in the true sense of the word, is one in which the selection method is practiced. Since the possibility of applying this particular silvicultural system in forests heretofore managed under another system is very rare and can be produced only with great sacrifices to final yield, practical foresters will think twice before considering a wholesale adoption of the true selection system as a generally desirable measure.

To American foresters Hufnagl's ob-

servations will probably seem strangely familiar. If we but substitute our highly overworked term "selective logging" for "selection forest" (or selection forestry), we have a perfect analogy of an identical situation as it exists in this country.

In the field of soils, the time-worn phrase "forest soil sickness" also comes in for a jolting rebuke. The writer claims that present evidence is insufficient to permit us to blame any sick soil condition as manifested by a decrease in yield and growth capacity upon increases in raw humus content and soil acidity supposedly brought on through pure stands following clear-cutting. Doubt is therefore expressed as to whether we have advanced sufficiently in soils investigative work to permit the making of far reaching changes in established forestry practices on the basis of a comparatively meager soils knowledge.

Dr. Hufnagl closes his discourse (which it must be admitted is a stimulating one whether we are in actual accordance with all his statements or not) by again emphasizing the importance of caution before over-enthusiastically adopting every newly proposed theory that comes along on the premise that since it was applied successfully in one given locality it could be applied everywhere. It is true that as progressive foresters we need an unlimited store of knowledge which must be constantly increased and broadened. And since in that respect personal experience must usually be supplemented by knowledge gained through a regular perusal of our literature it behooves us especially to exercise good common sense before actually putting any untried or newly found idea into effect.

WHY TIMBER STAND IMPROVEMENT?

By A. F. HOUGH

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Are the second-growth hardwood forests of the East in a satisfactory condition for the production of high-quality sawtimber? A study of the health and form of trees in well-stocked but unmanaged stands of the beech-birch-maple-hemlock type on the Allegheny Plateau indicates a serious situation. Certain timber stand improvement measures, designed to reduce the number of defective trees, are suggested.

THOUSANDS of acres of former virgin forest, on the Allegheny Plateau in northwestern Pennsylvania, logged between 1860 and 1910, now support dense stands of second-growth approaching merchantability which on casual inspection seem to be very satisfactory. Other less fortunate areas, especially where fire in logging slash and subsequent fires burned, have been reduced to scattered stands of aspen and pin cherry, between which grow brambles, bracken fern, goldenrod, and other herbaceous plants. The problem of rehabilitating these badly wrecked lands has been clearly recognized for a number of years and many acres have been planted artificially to aid Nature in restoring them to productivity. However, far too little attention has been paid to the equally important but less evident problem of improving the composition and quality of the well stocked stands of second-growth. Not until timber stand improvement work was started with the C.C.C. did the average forester or timberland owner realize the difficulty of the job of selecting and stimulating the growth of crop trees in stands which, in the relatively near future, should be the source of sawlogs and other high-grade commercial products.

Studies conducted since 1932 by the Allegheny Forest Experiment Station on the Kane Experimental Forest in northwestern Elk County, Pa., have resulted in a growing realization that well stocked second-growth forests, in which no previous cultural work had been done, contain many defective trees. Such stands are frequently of poor species composition with the dominant trees spreading and poorly formed while the individuals best suited to produce crop trees have been crowded into the understory. During an inventory cruise of the experimental forest in 1932 a total of 93 tenth-acre plots were tallied to secure data on the visible defects in the older second-growth stands. The second-growth stands on this 1,700-acre tract originated chiefly from advance seedlings and seedling sprouts present after logging of old-growth hemlock for sawlogs 45 to 50 years ago, and clear cutting of the remaining hardwood stand 30 to 40 years ago for use as chemical distillation wood. Some seedling and sprout growth originating after the cuttings completed the stocking of these stands. None of the older second-growth stands described in this article are third-growth, or the result of logging second-growth stands; in fact many holdover trees from the virgin forest are found scattered over the tract. Hemlock, formerly too small for sawlogs though often over 100 years old, and not desired for chemical wood, is one of the holdover species which has developed to sawlog size in the period following the commercial clear cutting.

Description of Stands Cruised in 1932

Table 1 gives the chief information secured in the five stands sampled, with percentages of the total number of trees

TABLE 1

THE PERCENTAGES OF THE TOTAL NUMBER OF TREES OF EACH SPECIES FOUND TO HAVE DEFECTS DUE TO FUNGOUS INFECTION OR MECHANICAL WOUNDS AND DEFECTS OF BOLE-FORM SUCH AS CROOK, LEAN, LOW LIMBS, OR FORKS.

Stand	Sugar maple	Red maple	Yellow birch	Sweet birch	Beech	Black cherry	Hemlock	Pin cherry[5]	Others	Total all species
(1) Plateau and north-facing slopes; well-stocked; 35-40 years old; basis 4.8 acres[1]										
Total no. of trees[2]	236	237	273	206	127	236	46	13	25	1,399
Species percentage	16.9	16.9	19.6	14.7	9.1	16.9	3.3	0.9	1.7	100.0
No. trees per acre	49.2	49.4	56.9	42.9	26.4	49.2	9.5	2.7	5.2	291.5
Percentage with bole-form defects[3]	5.5	5.9	9.1	8.2	20.5	14.4	4.3	0	12.0	9 6
Percentage with pathological defects	12.3	6.3	8.8	9.2	12.3	4.2	19.6	0	8.0	8.9
(2) Streambottom; poorly stocked; 35-40 years old; basis 0.6 acres										
Total no. of trees	15	19	8		4	53	3	...	6	108
Species percentage	13.9	17.6	7.4	..	3.7	49.1	2.8		5.5	100.0
No. trees per acre	25.0	31.7	13.3	...	6.7	88.3	5.0	...	10.0	180.0
Percentage with bole-form defects	26.7	5.3	0[4]	...	0	17.0	0	...	0	13.0
Percentage with pathological defects	13.3	26.3	12.5	...	25.0	0	0	...	0	8.3
(3) South-facing slope; well-stocked after old burn; 35-40 years old; basis 1.7 acres										
Total no. of trees	29	96	33	187	36	53	10	.	19	513
Species percentage	5.6	18.7	16.2	36.5	7.0	10.3	1.9	...	3.8	100.0
No. trees per acre	17.1	56.4	48.8	110.0	21.2	31.1	5.9	...	11.2	301.7
Percentage with bole-form defects	3.4	6.2	3.6	9.6	22.2	3.8	20.0	...	26.3	8.8
Percentage with pathological defects	3.4	8.3	2.4	2.7	11.1	0	0	...	0	3.9
(4) Plateau and northeast facing slopes; (Adjacent to stand No. 4); well-stocked; 30-35 years old; basis 0.6 acres										
Total no. of trees	91	41	32	25	33	168	4	19	9	422
Species percentage	21.6	9.7	7.6	5.9	7.8	39.9	0.9	4.5	2.1	100.0
No. trees per acre	56.8	25.6	20.0	15.6	20.6	105.0	2.5	11.9	5.6	263.7
Percentage with bole-form defects	1.1	4.9	3.1	4.0	18.2	20.2	0	0	0	10.7
Percentage with pathological defects	16 5	4.9	21.9	16.0	27.3	1.2	0	0	0	9.5

(5) Plateau and south facing slopes; (2 miles west of stand No. 4); well-stocked; 30-35 years old; basis 0.6 acres										
Total no. of trees	21	16	13	4	...	52	5	19	1	131
Species percentage	16.0	12.2	9.9	3.0	...	39.8	3.8	14.5	0.8	100.0
No. trees per acre	35.0	26.7	21.7	6.7	...	86.7	8.4	31.7	1.7	218.3
Percentage with bole-form defects	0	0	7.7	50.0	...	11.5	0	0	0	6.9
Percentage with pathological defects	14.3	0	15.4	0	...	3.8	0	0	0	5.3

[1]The sample for each locality was taken in the form of 1/10-acre plots spaced at 10-chain intervals on cruise lines 10 chains apart.

[2]Based on all trees 4 inches in d.b.h. and over.

[3]Defect percentages in table show relation of number of trees classed as defective to total number of sound and defective trees on plots for each species.

[4]Percentages underscored are not reliable being based on 10 trees or less.

[5]Pin cherry is usually of good bole form but subject to Nectria canker. Relatively few trees remain except in stand No. 5; these survivors show no external pathological defects but may be expected to die soon.

of each species found to have defects due to fungous infection or mechanical wounds due to insects, animals or other causes, (classed as pathological defects), and those found to have bole-form defects such as crook, lean, low limbs, or forks. A tree was tallied but once in each class regardless of the actual number of individual cankers, forks, or other defects present. If it possessed both pathological and bole-form defects, however, the same tree would appear in each category and the percentages in Table 1 overlap to this extent. Addition of values for the two classes of defect thus gives too great a figure for total defects. All defects tallied were of an external or visible character and much additional internal cull doubtless exists in many trees of sound exterior.

Each stand varies somewhat in its species composition, stocking, and past history. The best sample, (48 tenth-acre plots), was obtained in stand 1 which occupies an area of 556 acres ranging in elevation from 1,700 to 2,060 feet above sea-level on the plateau and north-facing slopes on the east side of the experimental forest. Fire after logging has disturbed but one area, stand 3, which lies on a south-facing slope at an elevation of 1,660 to 1,980 feet above sea-level and is well stocked, the chief species being sweet birch and red maple. It is interesting to note that this 35-40 year old stand is peculiarly free of pathological defects despite the abundance of sweet birch and red maple, both of which are very susceptible to Nectria cankering and heart-rotting fungi. Most of the stand originated as seedling growth after the severe logging slash fire of 1896. No subsequent fires have disturbed the area and basal scars are noticeably absent. The heat of the fire must have killed or discouraged sprouting of the stumps left after clear-cutting because sprout clumps of black cherry, sugar maple, and red maple are noticeably lacking here as compared with other clear-cut but unburned areas on the

experimental forest. These conditions have produced a stand of poor composition but with a minimum of pathological and physical defects, due mainly to the fact that seedling rather than sprout reproduction took over the area after the burn.

Between stand 1 and 3 is a narrow, poorly stocked stream bottom. Open grown black cherry, red and sugar maple, and yellow birch make up stand 2. The poor stocking of this stand is due partly to frost and rodent damage and partly to grazing by domestic stock and deer browsing. Stand 4 is located on a well drained plateau or divide between Wolf Run and the south branch of Hoffman Run at an elevation of 1,920 to 2,020 feet above sea-level. The stand was 30-35 years old in 1932 and living pin cherry still made up 4.5 per cent of the total number of trees. Black cherry and sugar maple were the chief species present, while on this dry site yellow birch was slowly losing out and 21.9 per cent had pathological defects. Stand 4 contained the highest all-species percentage of pathologically defective trees noted on the experimental forest, or 9.5 per cent.

Stand 5 is somewhat different in species composition from the previous stands; note the absence of beech and the relatively high percentage of pin cherry. For this reason, and since it is located on a slightly southerly aspect about two miles west of the other second-growth stands, data from this area are included in Table 1 for comparative purposes. A tree dissection study, made in 1936 by the Bureau of Plant Industry on a ¼-acre plot in this stand, indicates that very few fungous defects are present and that most of the trees are of seedling or seedling-sprout origin. This confirms the low all-species percentage of pathological defect obtained for this stand.

The result of combining the tallies of all five stands to secure a broad picture of conditions in second-growth sampled on approximately 1,100 acres is shown in Table 2.

The Problem of Bole-Form Defects

In general a greater percentage of the total of all species suffered from bole-form defects such as crook, forking, lean, or low limbs, than from visible defects due to tree diseases or mechanical wounds. The highest all-species percentage of trees with bole-form defects is 13 per cent for the poorly stocked stream-bottom stand 2. Less defect is found in the other stands in all of which the density of stocking is much better at the present date. Initial stocking and species composition during the period the dominant trees are putting on height growth, and expanding their crowns, is of great importance in determining the ultimate form of the crop-trees. In general an open, poorly stocked stand offers a greater opportunity for the trees to grow up into wolf trees with bushy, frequently forked crowns, and limby boles, than does an area fully stocked with species of similar growth rates. Stand 2 is an example of an open-grown stand in which the predominant black cherry and sugar maple are particularly limby.

Black cherry suffers greatly from bole-form defects in all except stand 3. The vigor and rapid growth of black cherry enable it to recover from attack by some

Table 2

SECOND-GROWTH STANDS 30-40 YEARS OLD ON THE KANE EXPERIMENTAL FOREST. BASIS 9.3 ACRES

Species	Percentage defective Bole-form	Percentage defective Pathological	Basis No. of trees
Sugar maple	4.8	12.8	392
Red maple	5.6	7.3	409
Yellow birch	7.3	8.8	409
Sweet birch	9.0	6.6	422
Beech	20.0	15.0	200
Black cherry	15.1	2.5	562
Hemlock	5.9	13.2	68
Others	7.2	1.8	111
All species	9.6	7.7	2,573

fungi, but unfortunately this same rapid growth rate causes it to "wolf" crown space and develop the usual bole-form defects of forking and low limbs. On clear-cut areas black cherry often reproduces by means of stump sprouts, or as clumps of multiple seedling sprouts, with the result that the boles are crooked and this sprout growth dominates all adjacent seedlings. Even when the stand later becomes fully-stocked, through the addition of tolerant seedlings of sugar maple and other species, the damage has been done and certain wolf trees entirely unsuited to sawlog production have crowded out all competitors. This accounts for the relatively high percentages of bole-form defect to be found in black cherry in stands 1, 2, 4, and 5. Seedling black cherries competing on an equal basis with other species of seedling origin, as in stand 3, grow to be clean-boled straight trees of good form.

Beech is another species which has a great deal of bole-form defect as well as pathological defect. In stands 1 and 4 most of the beech above 4 inches in d.b.h. are holdover trees, misshapen by suppression in their youth, which have developed spreading crowns and limby holes after release by logging. Even in stand 3, where most of the beech are of seedling or root sucker origin, the tolerance of this species has caused the retention of lower limbs and 22.2 per cent of the trees tallied had this and other bole-form defects.

Sugar maple has very good form, except in the poorly stocked stand 2 where the open conditions have resulted in bushy crowns. Red maple also has few bole-form defects in all stands. Yellow birch and sweet birch are of low to intermediate bole-form defect in all stands in which a reliable sample was obtained.

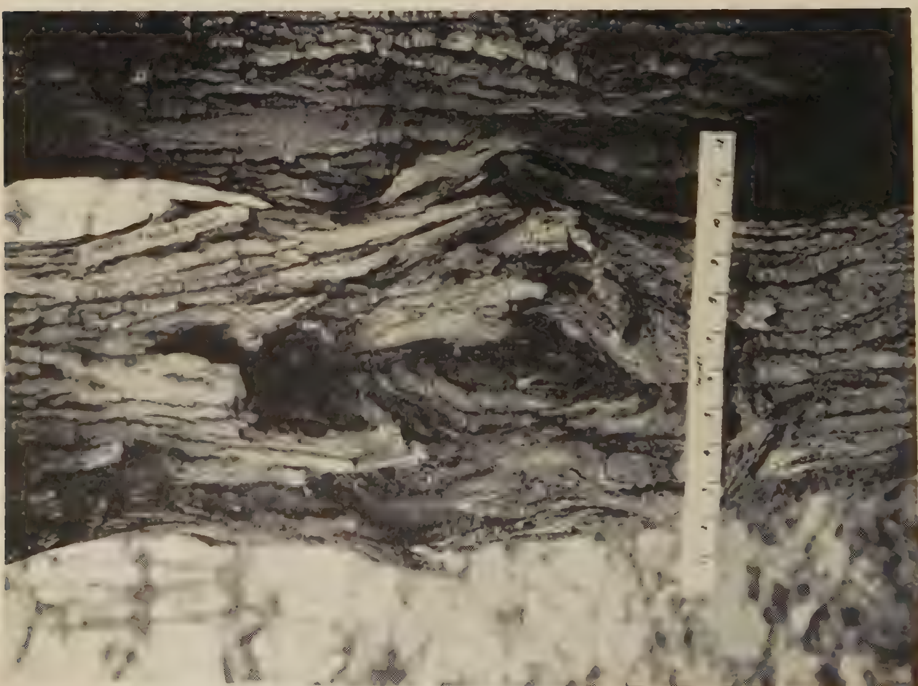
Pathological Defects by Species

In all stands black cherry is an important species and is relatively free of visible pathological defects.[1] This is fortunate since it is the most rapid growing species and will produce valuable sawtimber. Beech in these stands is highly defective as it is in New England (3). Andrews (1) has determined that beech is least susceptible to cankering on the Kane Experimental Forest and therefore the defects are chiefly due to the heart and sap-rotting fungi. Since the larger beech are all holdovers, or trees which developed from saplings present at the time of logging, it is probable that logging injuries have created points of entrance for various heart-rotting fungi, as have also bark injuries by rodents.

The small amount of hemlock left in these second-growth hardwood stands is invariably of holdover origin and is of great age. It is, therefore, like beech, subject to injuries which permit the entrance of fungi causing heart-rots. In stand 1 the 19.6 per cent of pathologically defective trees is an unfair criterion of the ability of this species to resist disease inasmuch as most of the larger hemlock left were culls rather than sound specimens.

Sugar maple is subject to a serious amount of pathological defect in all stands with the exception of stand 3. The history of this latter area indicates that defective holdovers and advance reproduction of sugar maple (sources of heart-rot and Nectria canker infection respectively) were killed by the fire of 1896, and that the seedling origin of the following stand precluded decay transmission from old stumps. Nectria cankering is probably more frequent where moist conditions favor infection and abun-

[1]Preliminary studies by the Bureau of Plant Industry indicate that seedling and seedling sprout black cherry are relatively free of rot but stump sprouts are subject to some decay from the parent stump.



A. Nectria canker on 40-year-old sugar maple.

B. *Fomes connatus* sporophores in basal wound on sugar maple.

C. Black cherry sprout growth on poor form and subject to rot hazard from old stump.

D. Forked black cherry split by wind or glaze storm.

Fig. 1.—Typical tree disease and bole-form defects.

dant inoculum is present. It is possible that removal of cankered advance growth and holdover trees by the fire, and the dryness of this denuded south-facing slope, may have materially reduced the chances of serious infection in the sugar maple reproduction which followed burning.

Red maple defect percentages vary from 0 in stand 5 to 26.3 per cent in stand 2, but these extremes are based on relatively few trees. In all other stands (even stand 3), red maple is rather defective as shown by Table 1. Since this species has been shown to be very susceptible to Nectria cankering much of the pathological defect in stands 1 and 4 is probably due to this cause.

As with most other species, yellow and sweet birch are low in pathological defects in stand 3, but in the other stands are intermediate to high in percentage.

The Nectria Canker Problem

Any agency which depreciates the present or future value of our second-growth forests should be recognized in the silviculture of the particular tree species and forest type affected. According to Welch (7), too little attention has been given by foresters to the damage done by parasitic fungi in immature stands of hardwoods in the East. Spectacular calamities such as the chestnut blight, Dutch elm disease, or white pine blister rust arouse popular interest and concern, but the damage done by native parasitic fungi which cause decay, cankers, and a reduction in the volume or increment of timber, as a rule goes unnoticed.

In 1934 Andrews (1) determined the occurrence of Nectria cankers by diameter class, crown class, and host species on the Kane Experimental Forest. In addition he obtained data on the number of cankers, their location, canker type, presence of fructification, means of entrance, and effect on host, for individual trees. A line plot system of sampling was used to cover about 8 or 9 per cent of the total area of each age class studied. Time permitted the sampling of but three age classes, a stand of 30-35 years, one 35-40 years old, and an old-growth stand. In all 6,753 trees were examined on 78 circular ⅛-acre plots distributed over 114 acres.

From this study it appears that red maple is the species most frequently cankered in all age classes sampled. A statistical analysis based on the percentage of trees cankered as well as the number of cankers per infected individual indicates the following order of species with regard to seriousness of Nectria infection: (1) red maple, (2) pin cherry, (3) sugar maple, (4) sweet birch, (5) yellow birch, (6) black cherry, and (7) beech. About 75 per cent of the observed cankers were restricted to the first 5 feet of the bole, 90 to 97 per cent to the first 10 feet, and 96-99 per cent to the first 20 feet. Branch cankers were not abundant. Cankered trees bore an average of 2.1 to 3.0 cankers each and the numbers of cankers seemed to be a good indication of the relative susceptibility of the individual tree and species. Red maple, pin cherry, beech, and black cherry had characteristic target-shaped cankers; while sweet birch, sugar maple, and yellow birch had cankers of variable form.

Cull due to Nectria depends on the number, location, and virulence of the cankers and also the uses to which products from the crop trees will be put. The greatest loss in merchantable volume will occur in red maple and sweet birch, while in sugar maple and other species losses will probably be relatively light because few virulent open cankers are found in the larger size classes. Damage due to the entrance of heart-rotting fungi and insects through open lesions should be considered in evaluating losses caused by Nectria infections. *Fomes connatus* sporophores are shown in an area of dead and decayed wood near the base of a sugar

maple in Figure 1 B. This wound probably originated as a Nectria canker or a logging scar.

During the fall of the year particularly, small, red, beadlike, fruiting bodies or perithecia are produced and the spores are blown by the wind or otherwise carried to infect neighboring trees. Infection commonly occurs in the axil of a small branch and results in the death of the twig or small branch which leaves a branch stub near the center of a target-shaped canker (6). On the Kane Experimental Forest 67 per cent of the cankers examined had originated in this manner, 23 per cent through some kind of an open wound or bark injury, and 10 per cent could not be determined. Both the location of cankers on the lower portion of the tree bole and the characteristic mode of entrance suggest that cankering tends to occur *early in the life of the tree* or before it has reached any considerable height.

This idea has been confirmed during a subsequent study of weeding by the crop tree method in four stands of young-growth. Intensive study of Nectria cankers on a random sample of 11 sugar maples in a 12-year-old stand, made by R. C. Lorenz of the Bureau of Plant Industry, and the author, indicated that infection had occurred when the trees were 6 to 11 years old and all cankers were below the 5 foot point. The fact that some infections were partly or entirely closed by callousing is encouraging and it is possible that stimulation of the growth of favored crop trees will greatly reduce the number of persistent cankers in the future stand. The Nectria canker problem, in common with that of bole-form, depends for its solution on the application of silvicultural methods of final cutting to secure good reproduction and the proper care in the early stages of development of this young-growth.

Reduction of Defects in Existing Stands

The preceding discussion indicates that the problem of bole-form, tree disease, and other defects, is quite serious in most second-growth stands resulting from clear-cutting in the beech-birch-maple-hemlock type on the Allegheny Plateau in northwestern Pennsylvania. In existing stands the disease situation may be improved by stand sanitation cuttings to remove the sources of fungus infection (4), (6), (7). Stand improvement cuttings may also be made to take out the poorly formed individuals and to benefit crop trees of the best species, form, and health. Weedings (5) to benefit the development of young-growth stands will also be useful, providing sufficient trees of desirable species, form, and origin, are available for treatment.

None of these measures will suffice when a large number of defective trees are present in a stand or when it is made up largely of inferior species. In such cases it must be clearly recognized that stand improvement can only result when regeneration of the better species is established and allowed to replace the defective overstory.

Silvicultural Measures for the Betterment of Future Stands in Northwestern Pennsylvania

Methods of cutting have much to do with the character and species of reproduction secured in this type. The practice of clear cutting large areas has favored those species able to sprout vigorously as well as the seedlings of such intolerants as pin cherry and aspen. Repeated clear cutting on a short rotation for chemical or pulpwood can only continue this process of stand deterioration.

In areas dedicated to sawtimber production it seems advisable to aid Nature in replacing the present unmanaged stands

of merchantable second-growth with desirable young-growth by cutting methods which favor seedlings of tolerant species. If the stand to be replaced is not of sufficient age to have an understory of advance growth already developed it should first receive a heavy thinning or reproduction cutting which will remove about one-third of the volume, in order to stimulate the germination and growth of seedlings prior to final cutting. Another method of approach would be use of a group selection system by which areas occupied by very defective trees are clear cut in small groups and vigorous well formed trees are left to cast seed and shade into the adjacent openings. A tree selection system could be applied in the least defective stands providing utilization was intensive and permanent roads available.

Use of such reproduction cutting methods would of course later be supplemented by the use of early weedings (2) to aid the development of future crop trees through correct spacing, selection of the better species, and the proper amount of release or crowding to insure good bole-form and crown development. If done at the time of final cutting, mowing may be employed to convert advance growth of poor form, or already diseased, into rapid-growing, straight-stemmed, seedling sprouts.

The Allegheny Station is making studies on permanent sample plots to determine the best methods of building up an understory of advanced seedling growth through final cuttings, and by thinnings. Methods of weeding to benefit young growth are also being investigated. These studies will be reported on as results become available.

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PRUNING SECOND GROWTH HARDWOODS IN CONNECTICUT

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Because of past cutting methods the second growth forests of Connecticut now consist largely of stands too open to prune naturally. At the same time, there appears to be an improvement in market for high quality logs. Such logs can be produced in large quantity only if these stands are pruned artificially. The present study shows that ladder and hand saw give good results on the "easy side" of the tree but poor results under adverse conditions. The pole saw requires more skill, especially when cutting larger branches at or near the upper limits of each and is somewhat more tiring. Although the pruning of stands where the branches are over two inches in diameter does not seem to be advisable the quality of material produced by other stands where the stocking is such that the trees do not prune naturally can be improved greatly by artificial pruning.

THE forests of Connecticut have always made important contributions to the economic welfare of the state. Full grown and easily available as an item of international trade to the earliest settler, the woodlands have continued to serve the needs of the industries which have come and gone since 1635. The demands of these industries have been varied and they each have left their characteristic mark on the present forest.

Metal working industries and the lime kilns of the western uplands, and the brick yards of the Connecticut Valley, demanded cordwood. The even-aged character of the present forest of adjacent portions of the state is the result. The selective cutting of specialized products for ship building and for the wagon and carriage industry also has had its effect on the present stands. Perhaps the influence of agriculture and of the railroads is most evident at the present time. The decline of Connecticut agriculture accompanied the rise of the railroad. Abandoned agricultural land reverts to hardwood forest growth, very little of Connecticut is within the New England white pine area. These abandoned lands re-seed to commercial species in a very irregular manner. If left alone, they will produce an uneven-aged stand characterized by wolf trees and seedlings from wolf trees together with much irregular competition from weed species.

The demands of the railroads for ties furnished many portable mill operators with a very easy market for local low grade timbers. In fact the market was so easy that the mill operators lost all contact with other outlets for Connecticut grown timber. The chestnut which furnished much of this tie material has been eliminated by the chestnut blight, but the expansion of the pressure treatment of ties has made the mixed hardwoods of the recently abandoned farm lands of value for this commodity. The customary method of cutting is to a one-tie limit or about 12 inches on the stump. This removes the wolf trees, the advanced seedlings if large enough, and leaves a stand too open for the best natural pruning but containing much potential high grade timber, particularly oaks. It does not seem as if railroad ties would be an important item in the future forest and this need can be supplied from the wolf trees and thinnings.

Therefore the problem is how to secure a fairly good quality of product from this rather widespread advanced growth with the expectation of having a sufficiently dense stand to form good forest conditions in the succeeding rotations.

The rapid cutting of the old growth southern hardwoods which now supply the markets would seem to indicate that there will be a place for quality hardwoods grown in the North by the time the

present crop matures. In fact, at present a limited market for such material exists, and clear logs 18 inches in diameter and up are in fairly steady demand, and at a fairly satisfactory stumpage price. The problem is to provide such quality in a stand which is too open to prune itself naturally, and in which it is desirable to secure increased natural regeneration of the valuable species.

With this in mind, a series of pruning experiments was initiated in 1932. The work has been carried out as a student problem and the information, as yet, is somewhat limited in character. The irregular branching of hardwoods seemed to indicate that the cutting time per branch is more valuable as a unit of measure than clear length of stem; therefore, the first season's work was on this basis. The first year's experiments were to determine relative efficiency of types of hand saws and the time required to cut branches of different diameters. The time was taken with a stop watch and was for the actual time in sawing. Work was from a ladder and elapsed time was not considered. The best type of saw seemed to be a thin bladed curved saw about 16 inches long, of the type known as "walnut" saw.

In Table 1 are given data which show the time in seconds required to prune branches of various diameters from different hardwood trees. In the light of more recent figures these values appear to be quite conservative.

Relationship of Branch Diameter to Pruning Time[1]

"This analysis is based on the data for all species combined. The branches with diameters above 5 inches are excluded because of the lack of sufficient data.

"One would expect on *a priori* grounds that the pruning time would increase as the diameter of the branch increased. But the area of the cross-section of the branch increases as the square of the diameter. Hence we might expect to find that the pruning time would increase, not with the diameter, but with the square of the diameter. If the actual average pruning times for branches of various diameters are plotted, it is found that the pruning time does increase as the diameter increases. It is noted also that the curve rises more and more steeply as the diameter increases. This would happen if the pruning time varied with the square of the diameter. Hence both on *a priori* grounds and because of the nature of the data as shown by the diagram, a second degree parabola was fitted to the points by the method of least squares. This is shown in Figure 1. When this parabola

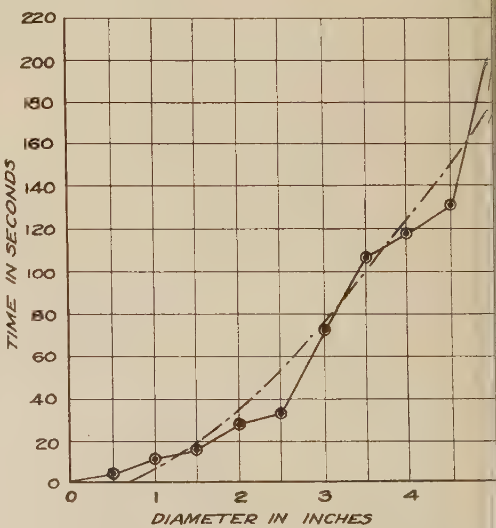

Fig. 1.—Relationship of branch diameter to pruning time. All species combined. The points in the circles connected by the straight lines are the actual averages of times taken for branches of the diameters noted. The smooth curve shown by a dotted line represents the general tendency for pruning time to increase as branch diameter increases. The formula for the curve is: $Y = -15.7 + 16.7X + 4.45X^2$.

[1]The analysis of Table 1 was made by A. E. Waugh, Economics Department, Connecticut State College.

TABLE 1

TIME REQUIRED TO CUT BRANCHES OF VARIOUS DIAMETERS FROM DIFFERENT SPECIES OF HARDWOOD TREES

Diameter of branches inches	White oak Number of branches	White oak Average time sec.	Black oak sp. Number of branches	Black oak sp. Average time sec.	Hickory sp. Number of branches	Hickory sp. Average time sec.	Maple sp. Number of branches	Maple sp. Average time sec.	Total Number of branches	Total Average time sec.
0.5	36	4.5	86	3.9	60	2.8	13	3.4	195	3.6
1.0	68	9.3	113	9.5	70	7.8	20	7.5	251	9.6
1.5	37	16.3	45	13.8	42	13.1	15	21.8	139	15.0
2.0	39	26.1	43	27.3	42	27.1	31	25.9	155	26.7
2.5	18	26.2	14	42.3	6	26.5	9	36.4	47	33.3
3.0	26	68.8	35	82.6	8	38.7	14	78.7	83	73.4
3.5	13	80.5	6	135.5	2	156.5	2	138	23	106.4
4.0	25	94.3	19	137.6	1	79	9	139.7	54	116.8
4.5	9	101	2	306			2	121	12	133
5.0	3	135	6	227	1	363			10	213
5.5	1	500	2	240			1	180	4	290
6.0	2	182	1	240					3	203
6.5										
7.0	2	450	7	407					9	414

is plotted it is seen that a smooth curve is obtained which is a fair description of the general tendency of the data. From the curve the average pruning time for branches of diameters from 1 inch to 5 inches inclusive can be estimated with a reasonable degree of accuracy. (The curve should not be used to estimate times for branches with diameters beyond this range.)

"The formula for the parabola is:

$$Y = -15.7 + 16.7X + 4.45X^2$$

In this formula Y is the pruning time in seconds, and X the branch diameter in inches. If it is wished to estimate the pruning time for a limb or known diameter, the diameter is substituted in the equation and solved for the pruning time. For example, if the diameter of the limb is 3 inches we get:

$$\begin{aligned} Y &= -15.7 + 15.7(3) + 4.45(9) \\ &= -15.7 + 50.1 + 40.05 \\ &= 74.5 \end{aligned}$$

That is, we expect that it will take 74.5 seconds on the average for limbs 3 inches in diameter. It will be noted from the original figures that the average time actually taken for 3-inch limbs was 73.4 seconds".

A study of the healing of the cuts and a study of the time required to make cuts indicate that 2 inches is about the largest branch which it is profitable to remove. This means that either more than one pruning is necessary or that only the trees in a stand sufficiently dense to keep side branches below this diameter should be considered for pruning. The elimination of the consideration of large side branches made it possible to compare the merits of the ladder and hand saw versus the pole saw.

A trial of the different types of pole saws available soon eliminated all except a pointed pole saw having a slightly curved blade set at an angle of 20° to the handle and cutting only on the down

stroke. The over-all length of this saw without additional sections is 9½ feet. The addition of one four-foot section makes it easily possible to prune to a height sufficient to give a sixteen-foot clear length.

The stand used in the comparative study was in the 30-40 year age class, thinned rather heavily, with defective trees and weed species removed. The remaining stand was largely oak with about 200 crop trees per acre. The crop trees were pruned to a height of 17 feet. The branch size ranged from ¼ to 3 inches; both live and dead branches were removed but were not separated in the records. The time records were in ¼-inch classes and the position of the branch on the tree was recorded by one-foot height classes. Thirty-five trees were pruned in this time study. A total of 465 branches was removed, of which 423 were one-inch or under in diameter. The spread in the 42 branches above 1 inch was such that these figures were not used in securing the trends of time in this study.

The time required to cut a branch of a certain size seems to have a definite relation to the height of occurrence above the ground. The higher the branch, the greater the length of time required to make the cut. This increase in time appears to be relatively uniform up to about 12 feet, but at that point a rapid increase in the time becomes apparent. No attempt was made to prune to a height greater than 17 feet. The wide spread in the results would seem to indicate that the personal factor entered into the use of a pole saw to a greater extent than in the use of the hand saw, especially when the operator had to reach above his head.

The figures in Table 2 show trends only. The diameter classes do not include branches of diameter greater than 1 inch, as the total occurrences were not sufficient to give even a trend.

The time tests of the ladder and hand saw were based on time per individual cut. The results are not directly comparable because of differences in type of stand where pruning was carried out and because the work was by different groups of students. Therefore an area of .67 of an acre was laid out in the even-aged thinned stand mentioned above. This plot was further subdivided into two areas of .4 acre and .27 acre. The first area was pruned using ladder and hand saw; the second area was pruned using the pole saw. The crop trees were pruned to a height of not less than 16 feet. The heavy thinning eliminating all of the lower crown classes enabled unimpeded movement of the ladder from tree to tree. The time therefore was the total time spent on the plot and includes lost time as well as actual sawing time.

The efficiency of pole saw over ladder and hand saw would increase with the increased difficulty of handling a ladder in an unthinned stand.

TABLE 2

TIME TRENDS FOR PRUNING WITH A POLE SAW (IN SECONDS)

Height of branch occurrence in feet	Branch diameter ¼ inch	½ inch	¾ inch	1 inch
3	.8	1.3	1.5	2.0
6	1.0	1.6	2.1	3.3
9	1.1	2.1	3.0	4.5
12	1.2	2.5	3.8	5.8
15	4.5	9	14	20

TABLE 3

A COMPARISON OF LADDER AND HAND SAW WITH POLE SAW PRUNING

	Ladder and saw	Pole saw
Area pruned	.4	.27
Number of trees	80	49
Total time	5 hr. 32 min.	2 hr. 58 min.
Lapsed time per tree	4 min. 8 sec.	2 min. 58 sec.
Actual time per tree	2 min. 42 sec.	2 min. 8 sec.
Lost time per tree	1 min. 26 sec.	50 sec.
Estimated time per acre	13 hr. 50 min.	9 hr.

The students working on this phase of the problem seemed to prefer the ladder as their report states it was "easier to prune the trees on a day basis with the hand saw and ladder. Also a better job of pruning could be accomplished."

Pruning is an attempt to save time on natural methods. It is to be expected that if pruning in hardwood is practical it will be carried out in relatively young stands where limb diameters are small. The opportunity for a comparison such as indicated in Table 3, but in a 20-30 year old stand, was offered when a heavy weeding and thinning were carried out in a mixed hardwood stand of this age class. The trees were pruned to a height of 15 feet. Only the crop trees were pruned. The travel distance between trees averaged slightly more than 15 feet. Here again the conditions for moving ladders were very favorable except that the slash from the thinning somewhat obstructed free movement.

Certain time limitations prevented this experiment being placed on an area basis; therefore 25 trees were pruned by each method. This gives a comparison figure which may be placed on an area basis if 200 crop trees are considered a full stand per acre.

The conclusion of the students who carried out this experiment does not agree with that expressed previously. Evidently the average size of branch and its position are important from the labor standpoint, as this group expressed the opinion that it was easier to use the pole saw. The 20-30 year stand pruned to 15 feet did not have as large an average branch and it also had a greater proportion in the heights under 12 feet, where the time trends of Table 2 show the most efficient labor output.

The question of the effect on the tree of the removal of live limbs is still to be investigated and can not be determined as yet. Inspection of the exposed cuts does not disclose evidence of fungus except that *Corticium roseum* appears on the exposed wood of maple in a few instances. No information seems to be available on the action of this fungus in live trees.

Inspection of pruned trees shows a very decided difference in growing over of cuts. Maple is so slow as to be very unsatisfactory while oaks are much more rapid and show excellent results in most instances. The trees with dominant tops, as would be expected, show the more rapid covering of exposed surfaces, but a tendency is apparent for the cuts under the heavier side of the crown to heal more rapidly than cuts on the opposite side. Cuts which are not parallel to the stem or not tangential to the stem leave short, one-sided stubs which are slow to heal. Cuts large enough to require cutting both from below and above to prevent splitting often break free, leaving torn fibers; and are slow to cover. Many cuts of 2 inches or more in diameter

TABLE 4

COMPARATIVE TIME FOR PRUNING 25 TREES BY LADDER AND HAND SAW AND BY POLE SAW METHODS

	Hand saw and ladder	Pole saw
Total time	1 hr. 18 min. 52 sec.	49 min. 2.6 sec.
Time consumed in pruning	1 hr. 8 min. 18.6 sec.	43 min. 21.5 sec.
Time consumed in travel	10 min. 33.4 sec.	5 min. 41.1 sec.
Average distance between trees	15 feet	15 feet
Average time to travel between trees	25.3 sec.	13.6 sec.
Average time to prune, per tree	2 min. 43.9 sec.	1 min. 44 sec.
Average time in pruning and travel per tree	3 min. 9.2 sec.	1 min. 57.7 sec.
Average branches per tree	11.8	18.5
Total number of branches per test	295	464
Average time to prune, per branch	14.2 sec.	5.6 sec.
Average diameter of branches	.88 inches	.85 inches

have completely covered over where the cut was made sufficiently close to the stem to cut the branch swelling.

The instructions this year were that all cuts should be through the branch collar parallel to stem and the cuts should be tangential. A translation of Dr. Hans Mayer-Wegehin's "Astung" received recently confirms this decision, as his review of European literature shows this practice to be recommended.

The second growth forests of this region are subject to the attack of strumella and nectria cankers. These fungi usually enter the main stem at the base of a branch. It is possible that the early pruning of branches on selected crop trees will act as a partial control and assure a mature stand free of cankers.

The conclusion of the students carrying out these experiments is that the ladder and hand saw gives the best cut on the "easy side" of the tree, but poor work results where the ladder interferes with the saw. The changing of the position of the ladder results in a great increase of elapsed time. The pole saw requires more skill, especially in the larger cuts at or near the upper limits of reach. It is somewhat more tiring to use, especially by unskilled labor. The actual sawing time on cuts is nearly the same. The use of a ladder increases the lapsed time per tree due to the slower movement between trees and additional time necessary to set up the ladder and climb to the various branches. Any increase in difficulty of movement of the ladder such as is found in an unthinned stand will rapidly increase the elapsed time.

The work in pruning in the hardwoods will be continued, using pole saws on unthinned areas. The use of ladders with unskilled labor may be continued in thinned stands but the pole saw will be used with skilled labor.

Pruning of stands where the branches are over 1 inch in diameter will be with ladder and hand saw. Pruning of stands where the branches are over 2 inches in diameter does not seem advisable both from the labor costs and from the exposure to fungi through the length of time required to heal over the exposed wood. These studies indicate a possibility of improving the potential quality of existing stands of timber where the stocking is such that natural competition does not provide natural pruning.

This work is still in an experimental stage. The results are somewhat uncertain due to the possibility of disease. Nevertheless, I am of the opinion that money spent in this form of crop improvement will yield better future returns than a similar amount spent in an attempt to convert a natural hardwood succession into a questionable coniferous management type.

THE RELATION OF CROWN DIAMETER TO CUBIC VOLUME OF ONE-SEED JUNIPER

By JOSEPH HOWELL, JR.

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One-seed juniper in the southwestern United States characteristically is many stemmed. For this reason, it is often impractical to determine the volume of such trees by means of the ordinary d.b.h. measurement. A statistical study of the volume of 124 one-seed juniper trees indicates that crown width and diameter at one foot appeared to be the most important combination of variables to be used in the compilation of volume tables for this tree.

ONE-SEED juniper (*Juniperus monosperma* (Engelm.) Sarg.) is a many-branched tree with a low sprawling habit of growth, covering extensive areas in southwestern United States. This species has been of inestimable value in the development of this region because it furnishes large quantities of fuel, fence posts and poles, and at times construction material. Furthermore, it is highly important as a watershed cover, especially on steep, stony slopes where the vegetation is scanty.

Because of its sprawling, many-stemmed habit, the form of the tree cannot be determined in the usual manner. In fact, the species has no form in the usual sense. Diameter breast high measurements are not always practicable because of rapid changes in the form of the main stem and the number of stems originating at or below this point. For this reason, in the volume studies undertaken, the diameter outside the bark at one foot above the average ground surface was measured. In addition to total heights, two crown diameter measurements were measured. Total age was determined from the stump, but no correction made for age to reach stump height. All stems and branches that would yield a four-foot stick two inches or over, outside bark, at the middle were measured. All measurements were carefully taken with a steel tape. From these measurements, the partial cubic volume of each tree was determined by formula, assuming that each four-foot piece was a four-foot cylinder with a diameter equal to the middle diameter outside bark.

The basic data for this study consisted of 124 trees taken at random along a road just south of Pine Springs, Arizona. The measurements were analyzed by correlation methods given in Ezekiel.[1]

In Table 1 is given the statistics of the 124 trees measured during the study.

The simple correlation coefficients between volume and each of the factors, diameter, height, crown and age, are given in Table 2. Since the significant and highly significant correlation coefficients for 122 degrees of freedom are only .17 and .23, all these factors are highly correlated with volume.

Testing the significance of the differences between these correlation coefficients by Fisher's Z test and using his 5 per cent level of significance shows that the coefficient +0.744 for crown and volume is just significantly larger than the others. Therefore, it may be concluded that crown diameter is more closely associated with partial cubic volume than any other measured factor if a linear relationship is assumed. The size of the crown of this species of juniper apparently influences the number of branches that may be used, especially for fuel, and in doing so is closely associated with the partial cubic volume. However, a single variable is

[1]Ezekiel, M. Methods of correlation analysis. New York. 1930.

TABLE 1

STATISTICS OF 124 ONE-SEED JUNIPERS

Statistics	Diameter at one foot	Total height	Average crown diameter	Age at stump	Partial cubic volume
	Inches	*Feet*	*Feet*	*Years*	*Cubic feet*
Mean	10.81	12.56	11.49	222	8.0
Standard deviation	5.81	3.83	4.72	98	12.1
Standard error of mean	0.52	0.35	0.43	8.8	1.1

TABLE 2

STATISTICS FOR SIMPLE CORRELATION WITH VOLUME

Variables	Regression equation	Coefficient of correlation	Standard error of estimate	Coefficient of determination
Diameter—volume	—5.77+1.27D	+0.604	9.61	0.365
Height—volume	—15.90+1.90H	+0.596	9.69	0.355
Crown—volume	—14.10+1.92C	+0.744	8.06	0.553
Age—volume	—7.56+0.07A	+0.583	9.80	0.340

TABLE 3

STATISTICS FOR MULTIPLE CORRELATION WITH VOLUME BASED ON TWO INDEPENDENT VARIABLES

Variables	Regression equation	Multiple correlation coefficient	Standard error of estimate	Coefficient of determination
Diameter—height—volume	—16.43+0.84D+1.21H	0.705	8.55	0.497
Diameter—crown, diameter—volume	—18.12+0.71D+1.60C	0.823	6.83	0.678
Diameter—age—volume	—11.17+0.89D+0.04A	0.674	8.90	0.454
Height—crown, diameter—volume	—18.46+0.66H+1.58C	0.764	7.77	0.584
Height—age—volume	—15.73+0.81H+0.06A	0.657	9.10	0.431
Crown—age—volume	—16.60+1.50C+0.03A	0.770	7.69	0.593

TABLE 4

STATISTICS FOR MULTIPLE CORRELATION WITH VOLUME BASED ON THREE INDEPENDENT VARIABLES

Variables	Regression equation	Multiple correlation coefficient	Standard error of estimate	Coefficient of determination
Diameter—height—crown—volume	—18.63+0.70D+0.19H+1.45C	0.812	7.04	0.659
Diameter—height—age—volume	—22.25+0.45D+1.29H+0.04A	0.755	7.91	0.569
Height—crown—age—volume	—24.17+0.93H+1.20C+0.03A	0.815	6.90	0.664
Diameter—height—crown—age—volume	—20.01+0.59D+0.28H+1.30C+0.01A	0.816	6.87	0.665

seldom used in the preparation of volume tables or in survey work. Ordinarily the diameter breast high and total height are used. For this reason a multiple linear correlation analysis was run to determine what other factors might be used as independent variables.

The results of this analysis using two independent variables with volume are given in Table 3. Since the significant and highly significant multiple correlation coefficients are only .25 and .29, all of these combinations of variables are highly correlated with volume. Unfortunately, no known test of significance is available to test the significance of the difference between two multiple correlation coefficients when the number of variables is the same in each equation. Therefore, it is impossible to state which of these equations is best statistically. However, because the multiple correlation coefficient between volume and crown width and stump diameter was larger than R for any other combination used, it was assumed that this combination was the most important of the two-independent variable combinations.

Additional multiple linear equations, based on three independent variables, were derived. These equations with their statistics are given in Table 4. The differences between equations 1, 3 and 4 are so small that they no doubt are not statistically significant.

Further studies will be made in order to determine more fully the influence of crown diameter on volume. Because crown width and diameter at one foot appeared to be the most important combination of variables, preliminary volume tables were compiled on this basis.

THE PROBLEM OF SELECTING THE DESIRABLE PINE SPECIES FOR FOREST PLANTING IN OHIO

By J. B. POLIVKA and O. A. ALDERMAN
Ohio Division of Forestry

The ten species of pine commonly planted in Ohio are affected by a considerable number of insects, several fungi, and the yellow-bellied sapsucker. A study was made of the prevalence of and the damage done by these agencies and it is concluded that white, jack, and Norway pines are the most desirable pines for forest planting in Ohio.

PLANTATIONS and natural stands of pine in Ohio have suffered from the attack of numerous insects, two leaf fungi, and yellow-bellied sapsuckers. On the basis of the extent of the damage caused by these agencies the authors have determined the suitability of the ten species of pine commonly planted in Ohio. White, jack, and Norway pines are considered to be the most desirable; Scotch, Corsican, and ponderosa pines, the least desirable, for forest planting in Ohio.

The extent of the injury and the insects responsible for the damage were not definitely known until an insect survey was conducted during 1934 and 1935. This survey was made possible through the cooperation of the Ohio Division of Forestry and the Department of Entomology of the Ohio Agricultural Experiment Station.

A large number of insects were found on pine but only 17 of them generally have been associated with pine by other workers. Therefore, these 17 insects only will be used in classifying the desirability of the pines. This number includes leaf feeders, tip moths, bark beetles, sucking insects, and wood borers. Thus, no particular group of insects will be considered in this discussion.

Two leaf fungi have caused considerable damage to several pine species. One of these was determined by R. U. Swingle, of the Bureau of Plant Industry, as *Coleosporium solidaginis* (Schw.) Thum., and the other, by P. E. Tilford, of the Department of Botany of the Ohio Agricultural Experiment Station, as a leaf blight whic has the *Septoria* sp. generally associate with it. The leaf blight fungus has bee the more devastating of the two, but the is no question that the first fungus lowe the vitality of the trees. However, Co sican pine seems to be the only o seriously affected. Lowered resistance this species is generally followed by a attack of some insect, especially the ba beetle.

The leaf blight disease is noticeab during the months of May and June an again in late August and September b cause of the browning of the needles those times. The trees recover to a gre extent from the early effects of this fung during July and early August and aga in October and November. It is durin these periods of "browning" that the tre seem to be most susceptible to bark beet infestation. The *Coleosporium* disea is noticeable during May and June whi the orange-yellowish spores are being d charged, but the old pustule lesions ma be found as late as August.

The yellow-bellied sapsucker causes co siderable damage, especially to Scot and Japanese red pine, in early spring l making evenly-spaced punctures throu the bark of the trunk. The injury do not kill the tree immediately but if a area 3 or 4 inches in width complete surrounds the stem, the bark dies. Dia eter-growth ceases at this point but abo it the trunk becomes greatly enlarge Thus, the tree is so weakened that breaks during strong winds. Areas i

jured to a lesser extent afford an ideal place for the Zimmerman pine moth, *Dioryctria* (*Pinipestis*) *zimmermani* Grt., to continue its life cycle and for the female pitch mass borer, *Parharmonia pini* Kell., to deposit its eggs. Both of these insects practically girdle the trees before pupating and thus accentuate the original damage caused by the sapsucker.

Table 1 shows the number of trees infested by the 17 insects, the number infected by the leaf fungi, and the number injured by the yellow-bellied sapsucker. The 10 pines listed are the only ones planted in more than one forest in the state.

The pines are listed in the table from the least susceptible species on the left to the most susceptible species to insects on the right. The Scotch pine is the most susceptible; the northern white pine and Japanese red pine are the least susceptible. However, when the leaf fungi and sapsucker injury are included there is a

TABLE 1

THE NUMBER OF TREES INFESTED BY INSECTS AND DAMAGED BY LEAF FUNGI AND THE SAPSUCKER

	Pinus strobus Linn.	*Pinus densiflora* Sieb.	*Pinus rigida* Mill.	*Pinus banksiana* Lamb.	*Pinus echinata* Mill.	*Pinus nigra* Arnold	*Pinus ponderosa* var. *scopulorum* Engel.	*Pinus nigra* var. *calabrica* Schn.	*Pinus resinosa* Ait.	*Pinus sylvestris* L.
Number of trees examined	2365	315	295	415	1725	550	500	1074	3880	4387
Aphrophora parallela Say	6	20	18	1	----	1	10	7	22	264
Dioryctria zimmermani (Grt.)	----	4	96	9	35	.8	11	33	67	114
Pachystethus oblivia Horn	1	----	----	----	6	2	27	9	51	56
Aphrophora saratogensis Fitch	----	----	----	2	2	----	4	3	11	32
Chionaspis pinifoliae (Fitch)	----	----	----	----	----	4	----	----	23	30
Rhyacionia frustrana (Comst.)	----	----	----	----	10	----	----	----	17	.
Thyridopteryx ephemeraeformis Haw.	18	2	3	2	15	2	1	3	19	16
Ips calligraphus (Germ.)	----	2	----	----	----	----	4	6	5	16
Rhyacionia comstockiana Fern.	----	----	4	1	----	----	35	1	2	14
Ips grandicollis (Eich.)	1	----	----	4	----	1	11	20	9	13
Neodiprion lecontei Fitch	----	----	----	----	61	1	----	1	----	6
Pineus strobi (Hartig)	1214	----	.	----	..	----	----	----	1	3
Lyda sp.	----	----	1	----	4	----	----	----	7	2
Parharmonia pini Kell.	----	2	----	----	----	----	----	----	----	5
Dendroctonus terebrans (Oliv.)	----	----	----	----	----	----	----	----	----	1
Retinodiplosis resinicola O. S.	----	----	13	----	----	----	----	----	----	1
Yellow-bellied sapsucker	1	115	5	1	4	2	----	6	----	249
Coleosporium solidaginis Thum.	----	----	24	----	785	86	18	329		
Leaf blight		.	.	.		2	170	224		

slight change in position and the list would read thus: white, Japanese red, jack, pitch, shortleaf, Austrian, Norway, ponderosa, Corsican, and Scotch pines.

The above lists are based on the total number of insects and other destructive agencies observed on pine. If the extent to which the trees are damaged is taken into consideration, the list becomes very greatly changed. The following paragraphs show the reasons why the above lists can not be wholly relied upon for use in selecting desirable pine species for planting in Ohio.

Inasmuch as the leaf blight fungus has been so destructive to Corsican and ponderosa pine that it was necessary to cut and burn some plots, it would seem prudent to place these species at the foot of the list. This fungus can be found on practically all of the Corsican and ponderosa pines in the Dean, Waterloo, and Hocking forests. Bark beetles enter these diseased trees that have been lowered in resistance and undoubtedly hasten the death of many of them. A further reason for placing the ponderosa pine at the bottom of the list with the Corsican pine next is that the former is also heavily infested with tip moths. Furthermore, this species of pine does not produce normal growth in any of these forest areas.

With the great number of sapsucker-injured trees added to the long list of those damaged by insects, the Scotch pine unquestionably should be placed third from the bottom. In northern Ohio, this pine is badly damaged by the Zimmerman pine moth. It is thought that many of the trees infested with bark beetles in the Dean forest were first damaged by spittle insects. Placing the Japanese red pine fourth from the bottom may not seem logical on the basis of the data presented. However in analyzing the general observations, it has been found that Japanese red pine does not thrive as a timber-producing tree under Ohio conditions and, in addition, it is highly susceptible to sapsuck attack.

The data given for the pitch pine not give a true picture of what actual occurs in natural stands. The tip mo infestation averages 43.8 per cent in pu stands of natural reproduction in c fields and 26.6 per cent in mixed har wood stands. A considerable number large trees of this species were dying the Shawnee forest. Evidence of ba beetles has been found in all of the de trees examined. In view of this eviden the pitch pine should be placed as t fifth least desirable species for plantin

Although the Austrian pine is infes by both of the leaf fungi, it can righ be placed sixth from the bottom, as fungi do not seem to affect its devel ment to any great extent and very f insect pests that have caused any noti able damage.

Bark beetles have killed many Norw pine trees in the Dean forest, but for whole area the percentage of loss been rather small. At the present ti the tip moth damage is slight.

The shortleaf pine is seriously dama by the sawfly and the tip moths prefe to the Norway pine. A large number trees of this species was found infec by the fungus, *Coleosporium solidag* (Schw.) Thum., but the infection is sl and it is doubtful if it has caused c siderable damage.

The jack pine has been seriously d aged by bark beetles in the Dean Hocking forests, and the reproduction the Waterloo forest has been infested sawfly. Otherwise, this pine is relati free from insect damage.

The weevil, *Hylobius pales* Boh., the leaf feeder, *Pachystethus oblivia* Hc have caused the greatest loss in the w pine. The weevil killed 6.3 per cen trees in one planting in the Dean fo and the leaf feeder surely lowered resistance of many trees in one plan in the Shawnee forest. The pine l

adelges, *Pineus strobi* (Hartig), infested 51.3 per cent of all trees examined but this insect is not generally considered a serious pest.

There is some disease affecting the white pine in the Hocking forest that causes the trees to turn brown and eventually die, but the identity of the causal agent has not been determined. If this condition should spread to the other areas, it would undoubtedly place the white pine farther down the list of desirable species.

Summary

1. It is impossible to select the desirable pine species for a given area from the standpoint of insect population alone.

2. All factors affecting the growth or normal development of any of the tree species in an area should be judged according to the damage wrought.

3. The rapid growth of a species should be taken into consideration if it is practicable to control the destroying factors, as in the case of the sawflies on shortleaf pine. It is possible that a mixed stand might control the sawfly, although no data are available to prove this statement.

4. Tip moth studies in the natural pine stands indicate that mixed planting may be the solution to many insect problems.

5. A general summation of the foregoing data and observations indicates that the list of preferred pine species should be revised to read as follows: white, jack, Norway, shortleaf, Austrian, pitch, Japanese red, Scotch, Corsican, and ponderosa pines.

KILN TEMPERATURES FOR NORTHERN WHITE PINE CONES

By RAYMOND C. RIETZ[1] AND OSCAR W. TORGESON

Forest Products Laboratory

Kilns have been used for extracting conifer seeds from cones for a considerable number of years. However, until comparatively recently these kilns were operated largely on an empirical basis. In the present paper results are reported of carefully controlled studies to determine safe working temperatures and humidities. The work of Messrs. Rietz and Torgeson shows that a kiln treatment up to 140° F. for a duration of 12 hours did not reduce the vigor of germination of white pine seed. Kiln temperatures of 160° F. definitely reduce the viability of the seed.

THE extraction of seed by means of dry kilns demands a knowledge of the temperatures and relative humidities that can be safely used without reducing the viability of the seed (2, 5). In a modern forced-air circulation kiln the most practical schedule for the drying of either green or partially dried seed cones is one that employs a constant temperature and constant relative humidity. The temperature used should be the highest and the relative humidity the lowest that the wet seed in the cones will withstand without injury.

This article describes the technic employed for determining the safe temperature and relative humidity for extracting seed from northern white pine cones. The work was done at the Cass Lake Forest Nursery, which is equipped with internal-fan kilns designed by the Forest Products Laboratory (6).

Procedure

Northern white pine seed cones were used for the experiments. The cones were all collected on the Chippewa National Forest from trees of the intermediate age class and 9 to 12 inches in diameter. The cones were picked between the 24th of August and the 30th of September, 1936, and stored on precuring trays piled i shed for approximately 1 month. precured cones were then divided acco ing to a randomization pattern into kiln charges of 16 trays each. Thus e experimental kiln charge was a repres tative sample of the original supply available cones.

Each experimental kiln run consistec a full kiln charge of 16 bushels of co The average moisture content of the co varied from 25.2 to 55.5 per cent at time the experimental kiln runs w made. Some cones were about half o whereas others were tightly closed quite green. The kiln trays were spa 4 inches apart to allow for complete pansion of the cones. Four kiln temp tures, 100°, 120°, 140°, and 160° F., w used for durations of 2, 4, 8, and hours. All the experimental kiln r were made at the same equilibrium m ture content condition; that is, the r tive humidities were adjusted for various temperatures used so that cones and the seed would not dry be a moisture content of about 6 per c As equilibrium-moisture-content data seed and cones were not available, w equilibrium-moisture-content data as g by Hawley (4) were used.

After the kiln treatment the trays i

[1]Acknowledgment is made to H. L. Shirley and R. H. Blythe, Lake States Forest Experi Station, for their suggestions in planning the experiments here reported and for their super and analysis of the germination work. Acknowledgment is also made to members of the sta the Chippewa National Forest and the Cass Lake Nursery for their cooperation in providin cones and operating the extractory.

ing up a kiln charge were shuffled and rearranged into two new groups, each representing the kiln run. These two groups of tray loads were handled separately through the cone shaking, seed dewinging, and seed cleaning process. To determine the effect of the various kiln treatments given the cones on the viability of the seed each of the two lots of seed obtained from each kiln run was sampled for germination tests. Samples for measures of seed purity and blind seed were obtained at the same time. The germination sample consisted of 1,000 seeds. Each sample was germinated in sand in sublots of 250 seeds, each sublot being germinated in a different sand flat. The seed samples were stratified for 1 month in sand which was held at 10 to 12 per cent moisture content and at a temperature of 41° F. The room in which the germination was carried out was controlled as to temperature, operating at 65° F. during the night and 85° F. during the day. The germinative capacity of the seed is taken as the number of seedlings germinated in a sample of 250 seeds on the 26th day of germination.

Analysis and Interpretation

The moisture content to which the cones and seed came when kiln dried at the various temperatures for the various lengths of time is given in Table 1.

At the higher temperatures and longer durations of treatment the cones reach an equilibrium condition at a higher moisture content and the seed at a slightly lower moisture content than wood. For practical kiln operation the equilibrium-moisture-content relations for wood are applicable to controlling the moisture content to which northern white pine seed is dried.

As the cones were partially air dried the available yield of seed without kiln treatment was found to be about 50 per cent. The yield of seed for the various kiln treatments is given in Table 2.

It is evident that the kiln treatments at 160° F. yield the maximum amount of seed in the shortest time. At a kiln temperature of 140° F. a satisfactory yield of seed was obtained in 8 hours.

Table 3 gives the percentage of the original number of seed sown that germinated after 26 days for the 16 different kiln treatments used.

A mathematical analysis of all the treatments at 140° F. and lower indicates that only one or two germinative capacity values can be considered significantly different from each other. There is no regularity in the trends indicated by these values, and it is highly probable that no real difference exists among any of the kiln treatments up to and including 12 hours' duration at 140° F. At 160° F. even for 2 hours of treatment the germinative capacity falls off and with continued

Table 1

MOISTURE CONTENT OF CONES AND SEED AFTER VARIOUS KILN TREATMENTS

Temperature °F.	Duration — Hours: 2		4		8		12	
	Moisture content—Per cent							
	Cones	Seed	Cones	Seed	Cones	Seed	Cones	Seed
100	26.8	13.2	14.2	10.3	19.6	10.1	12.2	8.7
120	16.6	8.8	25.7	7.8	9.6	5.9	11.0	6.3
140	24.5	7.6	10.4	5.6	10.0	5.2	10.9	5.7
160	12.7	6.0	9.5	5.6	9.6	5.6	9.2	5.3

treatment the viability of the seed is greatly reduced.

The average course of germination of the seed lots from the various kiln treatments is shown in Figure 1. The curves in Figure 1 have been corrected for the blind seed found in the seed samples. The various durations of the kiln treatments in the 100°, 120°, and 140° F. series of kiln treatments did not result in significant variations in the germinative capacity so that they have been averaged for durations of 2 to 12 hours, inclusive.

The interpretation of the curves in Figure 1 is very much the same as was found in the analysis of the apparent germinative capacity data as of the 26th day of germination. A kiln treatment up to and at 140° F. for a duration of 12 hours has not reduced the vigor of germination. Kiln treatments at 160° F. definitely reduce the viability of the seed obtained. Germination of the 160° F. 2-hour seed starts at about the same time as the seed lots from cones treated at the lower temperatures, but the rate of germination falls off after the 15th day. As the duration of kiln treatment at 160° F. increases, the time required for initial germination also increases. The ungerminated seed

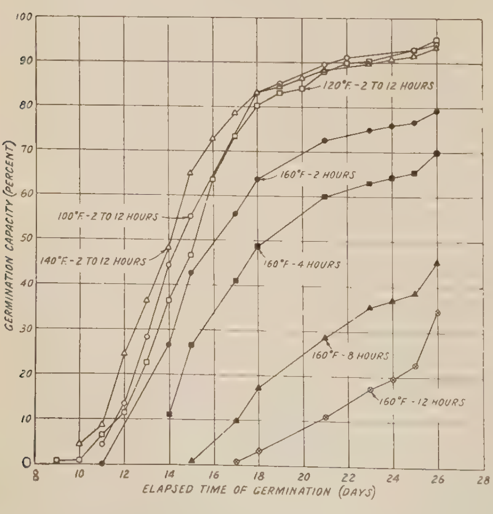

Fig. 1.—Course of germination of white pine seed after various cone treatments.

was lifted out of the sand on the 26th da of germination and inspected. The ri in the curves between the 25th and 26 days results from the addition of dampe off germinated seed and germinated se that had not had sufficient time to gro up through the sand.

Significance

The high germinative capacity valu obtained with the various kiln treatmen up to and including the 140° F. for duration of 12 hours would indicate very good seed crop. Toumey (7) dicates an average germinative capac of 66.7 per cent for northern white pi with the highest expected values being per cent. Barton (1) has shown t value of stratification in germinati northern white pine seed and for the t seed samples that were tested representi the 1927 and 1928 seed crops the g minative capacity values found after months of stratification were 71 per c and 33 per cent, respectively. Bates (tested samples of fresh northern wh pine seed of the 1928 seed crop and tained germinative capacity values of 6 per cent which he has termed "goo seed, but which could only be brought by stratification. The average germinat capacity of all the seed samples germ ated in the Forest Products Laborato experiments up to and including a 1 F. cone treatment for 12 hours in kiln is 94.1 per cent. This high germi tive capacity value was obtained in days of germination (after 1 month stratification) whereas Bates obtained germinative capacity value of 60.5 cent in 167 days, and Barton's germi tive capacity values were obtained in days. It is possible that the high g minative capacity is not only associa with an excellent seed crop but has b brought about by controlling the moist content to which the seed was dried the kiln.

The findings of this experiment are applicable to related seed crops and comparable dry-kiln equipment. The 1936 crop of northern white pine seed cones may be exceptionally vigorous withstanding higher kiln temperatures, and only repeat experiments with seed cone crops of other years will confirm the direct applicability of these findings to crops of other seasons.

A kiln temperature of 120° F. in "convection" kilns has been used in the past in the kiln drying of northern white pine cones. The difference of 20° F. between the limiting temperatures in the forced-circulation kiln and the convection kiln may be an indication of crop variation. On the other hand, convection kilns as a rule are not susceptible to good temperature control and the 20° F. difference may be the margin gained in kilns having good temperature control as well as relative humidity control.

These data were obtained in kilns having forced circulation and are only directly applicable in such kilns. With good temperature control the kiln can be operated near the limiting temperature of the species being dried and with forced circulation the time required to obtain good seed yield is reduced. The kiln treatments in these experiments have all been constant-temperature constant-equilibrium-moisture-content schedules. The findings indicate that a constant temperature of 140° F. can be used with an equilibrium-moisture-content condition of 6 per cent. At a kiln temperature of 140° F. it is necessary to maintain a relative humidity of 40 per cent in order to obtain the desired 6 per cent equilibrium-moisture-content condition.

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Table 2

YIELD OF CLEAN SEED PER BUSHEL OF CONES ADJUSTED TO A 5-PER CENT MOISTURE CONTENT

Temperature	Duration — Hours			
	2	4	8	12
°F.	Yield of seed—Pounds per bushel			
100	0.592	0.626	0.756	0.746
120	.709	.759	.838	.815
140	.776	.810	.880	.927
160	.880	.860	.869	.876

Table 3

MEAN APPARENT GERMINATION FOR THE VARIOUS KILN TREATMENTS

Temperature	Duration — Hours			
	2	4	8	12
°F.	Germination—Per cent			
100	94.05	93.08	93.32	90.12
120	94.55	96.82	92.62	92.90
140	94.55	93.05	91.92	93.02
160	79.02	69.92	45.35	34.72

APPLICATION OF PLANT PHYSIOLOGY TO THE PROBLEMS OF FOREST GENETICS

By N. T. MIROV

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Problems of forest genetics have received very little attention in the United States until comparatively recent years. These problems are difficult and, in many cases, will require years to solve. In the following article the author discusses forest genetics from the point of view of its relation to other biological sciences, chiefly plant physiology. It appears clear that the plant physiologist may make important contributions in the solution of forest genetical problems.

THE question of bettering forest stands by improving the quality of forest trees has occupied the attention of foresters for a long time. Silvicultural research has developed some methods of improving the quality of wood; it has found means to stimulate the rate of growth of trees; and has pointed out the necessity for great care in the collection of seeds for use in stand improvement. Studies of growth of trees of known seed sources have shown many hereditary tendencies of forest trees (13). Recently, attention has been directed to the purely genetical methods of improving forest trees. With the establishment of a genetics project in the Northeastern Forest Experiment Station and the acquirement of the Institute of Forest Genetics (formerly known after its founder as the Eddy Tree Breeding Station) by the California Forest and Range Experiment Station, a new impetus has been given to that branch of forest research generally known under the name of forest genetics. Therefore it appears appropriate and timely to discuss the subject of forest genetics from the point of view of its relation to other biological sciences, chiefly to plant physiology.

But before proceeding with such a discussion, it would be well to consider the definition of the term "genetics". Bateson (1), who in 1906 introduced this term, defined it as a science dealing with heredity and variation, and also as a study of selection. It appears that later this co cept was somewhat changed. Sinnott a Dunn (14) define genetics as "that bran of biology which is concerned with t phenomena of inheritance and variatio In other words, genetics is consider here as a purely theoretical science. general, the two terms "genetics" a "selection" have been used interchan ably, and the whole matter of nom clature is at present in a rather confus state. Such terms as the French "amel ration des plantes", the Spanish "gen ica", German "Zuchtung", or its cor sponding English term "breeding", all s nify the same thing, namely selection

Vavilov (16) states that selection a genetics are not synonyms. The lat deals with the problems of gene, w heredity and variation. It is a theoreti discipline and being such often uses jects which are of theoretical importa only, for instance the vinegar fly (*Dro phila*). Selection has a practical purp of improving the domesticated anim and cultivated (and in the case of f estry, wild) plants. Selection, in fact evolution directed by the will of man.

The point of importance is to und stand that this genetical enterprise n being undertaken for forest trees co prehends both theory and application is not concerned with genetics in its n row sense, but with the practical object also of developing a better strain of tr including disease-resistant forms, be

producers of turpentine, sugar, or tannin, or those producing a superior quality for lumber or pulp. On the other hand, it proposes not to breed by rule of thumb but rather on the basis of sound theoretical principles. Moreover, since so little work has been done by others in this field of the genetics of forest trees, the existing theory must, in important aspects, be built up through our own work, and in other aspects be amplified for or adapted to our forest tree domain. It is therefore entirely legitimate to designate our work as forest genetics.

This forest genetics enterprise, as thus contemplated, will have to be concerned with all the biological branches whose data enter into the genetical behavior of the trees. Among the most important of these branches is physiology, including its ecological and biochemical aspects. One of the deterring factors, for example, in respect to earlier attention to forest genetics has been the extended time required for the development of better strains of trees by purely genetical methods. Recent advances in physiology open up possibilities, not only of shortening this period, but also of developing better strains of trees without actual hybridization.

Regulation of Vegetative Period of Plants

The regulation of the vegetative period of plants is based on the fundamental hypothesis that every plant during its life has to pass through certain definite phases of development before it reaches the stage of flowering and fruiting. Growth of a plant and its phasic development are two entirely different things. A plant will grow indefinitely without development of fruits if one or another phase of its development is checked by improper external conditions. At present, two phases in the development of a plant are distinguished, namely the thermal phase, commonly known under the name of vernalization (6), and the light phase, which is related to the well known phenomena of photoperiodicity (4).

The regulation of the vegetative period of annual plants is already used in practice in plant breeding, acclimatization, etc. with surprising success (6, 9). In perennial plants, including forest trees, the phasic development has been studied only in relation to photoperiodicity. It has been found that modification of this phase alone causes considerable change in the vegetative period of a tree (12). Under natural conditions, the development phases in trees are stretched over a varying period of years, their intensity and duration depending on the species itself and on the external conditions as well. External conditions exert a great influence on the whole life of a plant, and especially on the time and periodicity of fruiting.

Experiments performed by Garner and Allard (5) with *Cassia maylandica* demonstrated how the flowering of this shrub can be either retarded or hastened by the length of day. Certain exotic species do not produce flowers when transferred to an environment with a different length of day. Merely an appropriate change in day to night ratio in the juvenile stage is sufficient to bring to flowering the species in question. It follows that by mastering regulation of growth of forest trees it may be possible to modify the length of their developmental phases to induce earlier flowering and fruiting, and thus to facilitate quicker results of tree breeding. Moreover, by applying the photoperiodic treatment, many plants can be rendered frost-resistant simply because their growing season is thus shortened, and such plants, transplanted into colder regions, will not be damaged by autumnal frosts.

Vegetative Propagation in Plants

In many instances, in forest genetics, it may be desirable to propagate a certain variety by vegetative means. Plant physiology can be of great assistance in this

case. Differentiation of cells in plants does not occur at the early stages of development only, as in animals. The meristematic tissues are found in plants in all stages of their development. Accordingly, every part of a plant where meristems are present or where tissues are potentially meristematic, is capable of reproducing the whole plant. The vegetative method of regeneration thus has great possibilities in the selection of plants. The chief peculiarity of vegetative regeneration is that in somatic tissue mitosis occurs during cell division as in contrast to the meiotic division of sexual reproduction. Therefore, no matter how heterozygous a certain form may be, it will always produce, when regenerated vegetatively, a progeny absolutely uniform in the hereditary sense, provided that somatic mutations do not occur.

It is of interest to mention that in plants which have been subjected to the photoperiodic treatment the reaction is transferred to the vegetative progeny (12). Some of the resulting modifications are of temporary character while others are rather stable (15). In some instances, the vegetative progeny obtained is of a variable character, depending on the time of taking cuttings and also on the place from which they have been taken. This phenomenon was named "topophysis" by Molisch (11), and can be explained by the varying differentiation of cells in different parts of a plant. For instance, in *Cunninghamia lanceolata* (a conifer resembling *Araucaria*), propagated vegetatively at Berkeley, it was noticed that the cuttings taken from the upper part of the stem developed normal plants, while those taken from the lower side branches did not develop straight stems but grew in a staggering manner. It therefore should not be concluded, from authorities who experimented only upon branch cuttings of a few species, that vegetative propagation of conifers in ge eral will produce only crooked specime and is not suitable for the production timber trees. Topophysis also depen on the age of the plant and the age of th branch from which the cuttings are o tained, and on the phase of developme of the plant or of its part which are us for vegetative propagation.[1]

Vegetative propagation is of treme dous importance in developing disea resistant trees. It is known, for instan that in Monterey cypress there sometim occur specimens that are resistant to t *Corynium* fungus which has seemed threaten to eradicate this species co pletely. From such specimens, by mea of vegetative propagation, a fung resistant strain can be developed in short time. If it were found that certa individual trees of white pine are resista to blister rust (which has been claime and if white pines could be propagat vegetatively (which may be possible), would be perfectly feasible to develop disease-resistant strain.

Biochemical and Ecological Aspect

For the better understanding of havior of plants in progeny tests or hybridization experiments, it is essent to know the botanical, geographical, a taxonomic position of parent trees. makes considerable difference what spec or variety is used in the experiments, a how closely related are the parents to used in hybridization procedure. The velopment of chemical analyses or sim physical tests is feasible in order to certain the affinity of various races o species.

For instance, the Pacific Coast form ponderosa pine is not uniform, but composed of several strains. Lemm (8) distinguished several of them in Sierra Nevada. The writer (10) o devoted a great deal of study to t

[1]The term "phase of development" should not be confused with the age of a plant. A p might be old in age but young in its phasic development.

species in California. The conclusion was that striking biochemical differences existed between several groups of this species which justify a closer study of the question. It should be kept in mind that physico-chemical methods are more accurate for differentiation between different species and forms than conventional morphological methods. According to the latter, even *Pinus jeffreyi* is considered by some as a variety of *P. ponderosa* (7).[2]

A problem in forest genetics might conceivably arise which would necessitate developing a strain of trees with certain chemical characters, as for instance that of a maple with a higher content of sugar in its sap. Here the whole genus *Acer* could be studied with regard to its botanical geography and the biochemistry of its sugars. It is not generally known, for example, that big-leaf maple (*Acer macrophyllum*), a Pacific Coast species, in one experiment recorded in the files of the California Forest and Range Experiment Station, produced twice as much sap as eastern sugar maple, with a much higher sugar content. In the selection of better pines as producers of turpentine, the physiology and biochemistry of oleoresin production of various races or species should be studied before any hybridization attempts are made.

How important environmental factors may be in the selection of a better species for a given locality may be exemplified by the introduction of Monterey pine to New Zealand. The new environment changed this species, unimportant in its native land, to an excellent timber tree.[3] This example shows once more that the whole development of a plant depends on the close interplay of internal and external factors. And it is quite probable that the former may be modified by the latter.

It is very important for a forest geneticist who tries to develop a new form of tree to take such phenomena into consideration. His aim is to obtain a genotype which would be suitable for a given region. He must understand well the climatic and other external conditions in which he wishes to grow his new form, in order to select a genotype which would give the most suitable progeny. One of the parents might, for example, have excellent qualities for a given environment, but under these conditions could not pass through its thermal phase, and thus would not flower. Appropriate physiological treatment might remove this difficulty and thus greatly simplify the breeding problem.

It is well known that differences in phenotypes do not always give a clear conception of genotypical differences of two compared forms. The same genotype developing under different external conditions may produce a different phenotype. Similarly, different genotypes developing under different external conditions may produce plants of the same external appearance. The characters of a plant are the result of its development, i.e., of interrelation of the plant and the environment. This concept helps an investigator to arrive at a correct understanding of the hereditary principles of plants. With an intimate knowledge of the developmental behavior of plants it may be possible, even before hybridization, to predict the behavior of the progeny under a given environment.

Physiology in Relation to Cytogenetics

Physiology of fertilization of forest trees is known only generally. The phenomena of parthenogenesis that have, for

[2]It should be noted that in the Forest Service "Check List" these two pines are treated as separate species.

[3]It should be noticed in this connection that Monterey pine, in its new country, acquired unusual ability for vegetative regeneration. Tall, straight trees were obtained by merely stripping down the branches and planting them in the open (3).

example, been reported by Blaringhem in many plants (2) should be studied and, if possible, induced by some physiological means. Since in these methods of regeneration no segregation takes place, it is evident that the process of selection in the progeny is greatly simplified. Parthenogenesis in flowering plants can be induced by certain hormone-like substances from pollen (without actual fertilization), or by sudden cooling of the ovary. In many cases, the causes of parthenogenesis are not known. The progeny obtained by parthenogenesis has a haploid number of chromosomes. Of course, haploid plants are almost always of inferior quality, but at the same time haploids are said to be easily transformed again into diploids. In inducing polyploidy in hybrids, plant physiology also will be of assistance to the cytogeneticist.

Great possibilities lies before the work in forest genetics. The writer's object in this review is not to detract from the importance of genetics proper in developing better strains of forest trees, but to show by a few examples how some other sister sciences, and especially modern plant physiology, can be of assistance in the not-too-easy problem of forest genetics.

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THEORY AND COMPUTATION OF THE PROPERTY TAX ON FORESTS[1]

By BESSE B. DAY AND A. Z. NELSON

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In the usual forest finance calculation property taxes are taken care of in an unrealistic and inaccurate manner. In this article the authors explain and illustrate the theory of the property tax on forests and its relation to forest value. They suggest the use of certain mathematical formulas for the theoretical computation of property taxes on forests and forest value under various forms of management. The application of the formulas are illustrated in most cases by examples. The article is based on the theory contained in part 3 of "Forest Taxation in the United States", (Misc. Pub. 218, U. S. Dept. Agr.) and 6 of its 19 formulas are repeated from that publication.

ONE prerequisite of sound business management is consideration of anticipated future economic developments. All elements of cost (expense items) required in the productive process are weighed in relation to the expected receipts from the enterprise. The production of forests is different from other types of business enterprise in that instead of obtaining an annual income a period of waiting is usually necessary before income is received. Before an individual decides to engage in forestry he should make a study of the elements of cost, the risks, and the probable returns from the enterprise. One of the costs involved is the property tax.

The purpose of this article is to explain the theory of the property tax relative to forests and to present various property tax and value formulas which may be useful to the forest owner in arriving at an estimate of the burden of taxes and the theoretical value of his property. A few of the formulas and their derivations will be found in part 3 of U. S. Dept. Agr. Misc. Pub. 218, "Forest Taxation in the United States" by Fred R. Fairchild and Associates (1), but for the most part they are new to forestry literature. While the object has been to include a compendium of the more useful and important formulas which, in general, cannot be found elsewhere, these formulas do not cover all of the problems involved in forest tax computations. However, they should serve as a basis for the development of supplementary formulas designed to meet specific conditions where needed. The formulas included for the theoretical determination of value may prove useful in comparing the financial possibilities of two or more forest properties, for checking an appraisal made by some other method, and for assessment purposes, although, as pointed out in "Forest Taxation in the United States" (1, p. 544), the discount formula as an aid to assessment for taxation has its limitations. Formulas for special forest tax plans such as those recommended by the Forest Taxation Inquiry, by authors of textbooks on forestry, and those now in effect in some of the states, have not been included. The more conservative investor will continue to estimate the amount of his future taxes on the basis of the ad valorem property tax, except in a few states where more favorable alternatives are available under well-supported special forest-tax laws. No attempt has been made in this article to discuss the theory or importance of other forms of taxation affecting forest properties. Income taxes, however,

[1]The writers are indebted to R. C. Hall, Director, Forest Taxation Inquiry, for assistance and advice in preparation of this article, and to members of the Taxation Staff and W. N. Sparhawk for valuable criticisms and suggestions.

must be considered in determining net returns to the owner but their treatment is simplified by the fact that they are payable only when income is realized (1, pp. 405-419).

Statement of Basic Principles

Certain basic principles should be stated to facilitate an understanding of the theory of the property tax as it applies to forest properties. The fundamental economic concept upon which the value of capital rests is that it is the result of discounting—capitalizing—all future incomes and elements of cost. Hence the expected future incomes and costs need to be considered in determining what is an equitable price to pay for an investment such as land for growing forests. Reversing the point of view, the future income which would justify such investment will be built up by accumulating to the income period at a pure (tax and risk free) interest rate, the initial investment and all items of expected expense incurred (1, p. 578). The value of capital, from this reversed viewpoint, tends to increase at a pure interest rate. When expenses occur they serve to add to the value of capital and they, in turn, are subject to increase at the same rate of interest. Taxes are items of expected expense, and hence add to the capital value of the forest property when paid. Conversely, income received results in an immediate decrease in the capital investment. The passing of time always assumes a working of the capital investment and hence an accumulation of interest on such capital. Interest is a carrying charge in forestry ordinarily exceeding taxes in importance (1, pp. 261-264). It is inexorable and must be taken into account in all cases involving a period of waiting (4).

Property taxes are levied not only on the initial investment but also on those parts of the value reflecting payment of taxes, interest on such taxes and expenses, and interest on expenses less income received. Since taxes must be paid before the receipt of income, a deferred-yield forest is overburdened under the property tax as compared with property yielding an annual income (1, pp. 40-47).

When reference is made to the building up of value through payment of taxes and other expenses and accumulation of interest, the assumption is of future returns and intermediate expenses all definitely foreseen, in which case value at any time depends on the period of waiting for the returns and the amount of expense still to be incurred. Value would exist only if discounted future receipts less discounted future expenses left a positive amount. Under the above assumptions the payment of taxes and other expenses are regarded as increasing value, and realization of income as reducing value.

There are two methods that may be employed in allowing for non-insurable risk—either including it by an addition to the interest rate or deducting an adequate allowance from the expected future income of the enterprise. The latter method has been adopted in this presentation. Thus the interest rate, p, represents pure interest, tax and risk free, and Y would be the expected major income after allowing for risk. This method has been considered most desirable because of ease of computation and because treatment of risk as an addition to the interest rate may lead to unreliable results when employed for long periods due to the nature of compound interest (4). Theoretically it makes no difference with respect to estimating tax costs whether risk be considered as an addition to the interest rate or as a subtraction from future income if an equivalent allowance is made in either case. The value of property on which taxes are levied is unaffected by the allowance for

risk since in theory this allowance is used up annually as an insurance premium or as a contribution to a contingent reserve. Although this is true in the theoretical computation of the future yield of a forest property, in the actual course of events part or all of the allowance for risk may become profit if the margin is over-liberal or the unfavorable contingencies do not materialize, or conversely the depletion may be greater than the estimated allowance, thus involving a loss of income. In allowing for non-insurable risk, consideration should be given to such physical hazards as fire, insects, disease, drought, and wind as well as economic hazards affecting the stumpage price such as loss of markets and competition of wood substitutes.

The income cycle, n, is considered to be the period between successive major yields. For a forest composed of a single-age class it is equal to the rotation, while in the case of an uneven-aged forest it is the period between the final yields of the successive age classes. An uneven-aged forest may be considered to be a selection forest consisting of a series of age classes commingled or it may be regarded as consisting of a regular series of even-aged stands. The cost of regeneration incurred at the beginning of the first income cycle of any forest is regarded as part of the permanent investment, while the cost of regeneration incurred at any later time is regarded as an expense chargeable to the major yield received at that time. In an even-aged forest, the initial forest value is the land value plus the regeneration cost. For an uneven-aged forest the land value is that of a corresponding even-aged forest. The initial value of any forest is taxable the first year while the increase in value reflecting the payment of expense is not taxable until the second year. All incomes are treated as occurring at the end of the year. Intermediate incomes from thinnings, partial cuttings, etc., may be received regularly or irregularly from a forest the major yield of which is deferred. The receipt of intermediate income changes the value of the forest property. The total yield from the forest would be the major yield plus all intermediate incomes brought forward to the time of the major yield at the pure interest rate.

The usual method of computing property taxes as a specific payment per acre is unrealistic when a period of deferment is involved and does not conform to actual conditions. The property tax is related to value and with a constant rate would vary directly with value. The determination of the property tax rate to be used in the mathematical computations is based on past experience and can be more accurately forecast than can an average annual sum, hence the inclusion of taxes at a constant rate, r, on actual value (1, pt. 3).

A Practical Illustration of Basic Principles

The foregoing discussion applied to the forestry business may be illustrated by a concrete example. Assume an even-aged forest with an initial forest value, V_0, of \$5 per acre of which \$1 is land value, L, and \$4 regeneration cost, C. Furthermore, let the pure interest rate, p, equal 3 per cent; the tax rate, r, 1 per cent; and annual expenses, e, \$0.05 per acre. The value of this property at the beginning of the first year will be \$5. The first year's taxes, 1 per cent of \$5, equals \$0.05 levied on the value at the beginning of the year but payable at the end. The value at the end of the first year or the beginning of the second will be found by accumulating the value at the beginning of the first year at 3 per cent and adding the first year's taxes and expenses, thus, $V_1 = \$5 \times 1.03 + \$0.05$ (taxes) $+ \$0.05$ (expenses) $= \$5.25$; the second year's taxes $=$ 1 per cent of \$5.25 or \$0.0525, and the

TABLE 1

THEORETICAL RELATION OF THE PROPERTY TAX TO THE INCREASING VALUE OF AN EVEN-AGED FOREST—PER ACRE BASIS[1]

		Increase in value reflecting:			Value components—cumulative		
Year	Value at the beginning of the year	Interest, 3 per cent	Taxes, 1 per cent	Annual expense	Amount on initial value at 3 per cent	Taxes with interest	Expense with interest
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	$5.0000	$0.1500	$0.0500	$0.05	$5.1500	$0.0500	$0.0500
2	5.2500	.1575	.0525	.05	5.3045	.1040	.1015
3	5.5100	.1653	.0551	.05	5.4636	.1622	.1545
4	5.7804	.1734	.0578	.05	5.6275	.2249	.2092
5	6.0616	.1818	.0606	.05	5.7964	.2922	.2655
6	6.3540	.1906	.0635	.05	5.9703	.3645	.3234
7	6.6582	.1997	.0666	.05	6.1494	.4420	.3831
8	6.9745	.2092	.0697	.05	6.3338	.5250	.4446
9	7.3035	.2191	.0730	.05	6.5239	.6137	.5080
10	7.6456	.2294	.0765	.05	6.7196	.7086	.5732
11	8.0014	.2400	.0800	.05	6.9212	.8099	.6404
12	8.3715	.2511	.0837	.05	7.1288	.9179	.7096
13	8.7563	.2627	.0876	.05	7.3427	1.0331	.7809
14	9.1566	.2747	.0916	.05	7.5629	1.1556	.8543
15	9.5729	.2872	.0957	.05	7.7898	1.2860	.9299
16	10.0058	.3002	.1001	.05	8.0235	1.4247	1.0078
17	10.4561	.3137	.1046	.05	8.2642	1.5720	1.0881
18	10.9243	.3277	.1092	.05	8.5122	1.7284	1.1707
19	11.4113	.3423	.1141	.05	8.7675	1.8943	1.2558
20	11.9178	.3575	.1192	.05	9.0306	2.0704	1.3435
21	12.4445	.3733	.1244	.05	9.3015	2.2569	1.4338
22	12.9922	.3898	.1299	.05	9.5805	2.4545	1.5268
23	13.5619	.4069	.1356	.05	9.8679	2.6637	1.6226
24	14.1543	.4246	.1415	.05	10.1640	2.8851	1.7213
25	14.7705	.4431	.1477	.05	10.4689	3.1194	1.8230
26	15.4113						

[1]Assumptions: Initial value, V_o, is $5—made up of $1 land value, L, and $4 regeneration cost, C. Pure interest rate, p, 3 per cent; tax rate, r, 1 per cent; annual expense $0.05. Rotation period ($n = 25$ years) = income cycle. No intermediate income. The margin for risk is depleted annually and does not enter into the computation.

Sources of data: Column 1, each year, after the first (which is the initial value V_o) computed by multiplying the value of the preceding year by 1.03 and adding columns 3 and 4 for that year, i.e. value beginning of the 5th year = $5.7804 × 1.03 + $0.0578 + $0.05 = $6.0616. Column 2, 3 per cent of Column 1. Column 3, 1 per cent of column 1. Column 4, assumed constant annual expense. Column 5, first year = $5 × 1.03, each year thereafter either equal to the preceding year's figure multiplied by 1.03 or initial value accumulated at pure interest rate for a period equal to the nth year, thus $V_o\,(1 + p)^n = \$5(1.03)^n$ i.e. for the 5th year $\$5(1.03)^5 = \$5 \times 1.1593 = \$5.7965$. Figure in Column 6 (Glover's tables $(1 + i)^n$, for interest factor) (2). Column 6, for the preceding year multiplied by 1.03 plus column 3 current year, i.e. for the 5th year $0.2249 × 1.03 + $0.0606 = $0.2922. Column 7, first year annual expense $0.05, each year thereafter either equal to preceding year's value multiplied by 1.03 and $0.05 added, or the amount of an annuity payment of $0.05 for the number of years indicated,

$$e\,\frac{(1+p)^n - 1}{p}$$ (Glover's tables $\frac{(1+i)^n - 1}{i}$, for annuity factor (2)) i.e. for 5th year

$$\$0.05\,\frac{1.03^5 - 1}{.03} = \$0.05 \times 5.3091 = \$0.2655.$$

value at the end of second year and the beginning of third year, V_2=\$5.25×1.03+\$0.0525 (taxes)+\$0.05=\$5.51; V_3=\$5.51×1.03+\$0.0551+\$0.05=\$5.78 and so on.

This process may be repeated for any number of years. Table 1 shows the results of building up such a value for 25 years. It illustrates in columns 2—4 the theoretical manner in which a forest property increases in value reflecting taxes, expenses, and interest. The cumulative value components for a particular year are given in columns 5—7. Thus, the value at the end of the first year or the beginning of the second, \$5.25 (column 1), is made of \$0.05 tax, \$5.15 amount of the initial value at 3 per cent for one year and \$0.05 annual expense. At the end of the 25th year the value is \$15.41 made up of \$3.12 taxes with interest, \$10.47 amount on initial value, and \$1.82 expenses with interest. When the forestry enterprise may be started with partially or fully stocked forests at a cost usually less than the cost of producing an equivalent forest by buying bare land and planting, the basic theory is applicable but the financial returns from the enterprise would obviously be greater (1, p. 237).

Formulas Applicable to Deferred-Yield Forests

Representing the various items of the above example in algebraic terminology and carrying through the operation illustrated in Table 1, general formulas expressing the relationships of value, taxes, and income, applicable to both even and uneven-aged, deferred-yield forests, may be developed (1, pt. 3).

Let p=pure interest rate, r=tax rate, e=annual expenses, n=length of income cycle, Y=yield, C=cost of regeneration, L=soil expectation or land value, V_o= the initial forest value (value at the beginning of income cycle), and $(1+p)^n$= amount of 1 at compound interest at p rate for n years.[2]

V_1, value beginning of the second year, $= V_o(1 + p) + rV_o + e$, or

$$V_1 = V_o(1 + p + r) + e;$$
$$V_2 = V_1(1 + p) + rV_1 + e, \text{ which is}$$
$$V_o(1 + p + r)^2 + e(1 + p + r) + e$$

(substituting value of V_1 in terms of V_0).

Likewise,

$$V_3 = V_2(1 + p) + rV_2 + e, \text{ which is}$$
$$V_0(1 + p + r)^3 + e(1 + p + r)^2 + e(1 + p + r) + e.$$

Suppose an intermediate income, T_{m_1}, is received at the m_1th year, then

$$V_{m_1} = V_o(1 + p + r)^{m_1} + e(1 + p + r)^{m_1-1} + e(1 + p + r)^{m_1-2} + \ldots + e - T_{m_1}, \text{ and}$$
$$V_n = V_0(1 + p + r)^n + e(1 + p + r)^{n-1} + e(1 + p + r)^{n-2} + \ldots + e - T_{m_1}(1 + p + r)^{n-m_1}.$$

If subsequent incomes T_{m_2}, T_{m_3}, . . . are received at m_2, m_3, . . . years similar

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[2] $(1 + p)^n$, etc. is used in preference to $1.0p^n$, the more common expression found in forestry literature. From a pure mathematical viewpoint the latter is inaccurate, meaning in fact unity times p raised to the nth power while the correct implication should be the nth power of the sum of unity and the interest rate (3, p. 15). Aside from the theoretical inaccuracy of $1.0p^n$ this form of expression does not lend itself readily to the algebraic manipulations necessary in the development of the formulas which follow.

terms will appear in the expression for value. The sum of such terms may be expressed as a summation, that is,

$$T_{m_1}(1+p+r)^{n-m_1} + T_{m_2}(1+p+r)^{n-m_2} + T_{m_3}(1+p+r)^{n-m_3} + \dots = \sum T_{m_j}(1+p+r)^{n-m_j}.$$

Summing the terms containing e,

$$V_n = V_0(1+p+r)^n + e\frac{(1+p+r)^n-1}{p+r} - \sum T_{m_j}(1+p+r)^{n-m_j}.$$

The value, V_n, is equal to Y + L, hence:

$$Y = V_0(1+p+r)^n + e\frac{(1+p+r)^n-1}{p+r} - \sum T_{m_j}(1+p+r)^{n-m_j} - L.$$

It is expected that the major income, Y, will be received from the forest at the end of every n years and that the regeneration cost, C, will be incurred at the beginning of each income cycle, therefore C should be subtracted from each member of the equation. Formula 1 is obtained by substituting V_0 for L + C and collecting terms. The major yield less regeneration cost for a forest with a continuous cycle of production is expressed in terms of initial forest value, annual expenses, income from thinnings, and taxes, by formulas 1 and 2.

FORMULA 1 (Including taxes as an addition to the interest rate)

$$Y-C = V_0\left[(1+p+r)^n - 1\right] + e\frac{(1+p+r)^n-1}{p+r} - \sum T_{m_j}(1+p+r)^{n-m_j}$$

Formula 1 and other formulas which follow may be illustrated by the use of data from Table 1 and Glover's tables (2), thus,

$$Y-C = \$5\left[1.04^{25}-1\right] + \$0.05\,\frac{1.04^{25}-1}{.04} - \$0, \text{ and}$$

$$Y-C = \$5 \times 1.6653 + \$0.05 \times 41.6459 = \$10.41.$$

This corresponds with the value obtained from Table 1, i.e., \$15.41 — \$5 = \$10.41.

Expressing the sum of all the taxes accumulated to the end of the period (see Table 1, column 6) as X, then Y—C may be written:

FORMULA 2 (Including taxes as a separate item)

$$Y-C = V_0\left[(1+p)^n - 1\right] + X + e\,\frac{(1+p)^n-1}{p} - \sum T_{m_j}(1+p)^{n-m_j},$$

thus, $$Y-C = \$5\left[1.03^{25}-1\right] + \$3.12 + \$0.05\,\frac{1.03^{25}-1}{.03} - \$0,$$

$$Y-C = \$5 \times 1.0938 + \$3.12 + \$0.05 \times 36.4593 = \$10.41.$$

The initial forest value of a property may be found by solving formulas 1 and 2 for V_0.

FORMULA 3 (Including taxes as an addition to the interest rate)

$$V_0 = \frac{Y - C + \sum T_{m_j} (1 + p + r)^{n-m_j} - e \dfrac{(1 + p + r)^n - 1}{p + r}}{(1 + p + r)^n - 1} \quad (1, \text{p. } 60),$$

thus,

$$V_0 = \frac{\$14.41 - \$4.00 + \$0 - \$0.05 \times 41.6459}{1.6658} = \$5.00.$$

FORMULA 4 (Including taxes as a separate item)

$$V_0 = \frac{Y - C + \sum T_{m_j} (1 + p)^{n-m_j} - X - e \dfrac{(1 + p)^n - 1}{p}}{(1 + p)^n - 1} \quad (1, \text{p. } 59),$$

thus,

$$V_0 = \frac{\$14.41 - \$4.00 - \$3.12 - \$0.05 \times 36.4593}{1.0938} = \$5.00.$$

Formula 3 or 4 is the ordinary type of formula for finding the present worth of a perpetuity.

Expressions for land value may be determine by substituting $L + C$ for V_0 in formulas 3 and 4 and solving for L.

FORMULA 5 (Including taxes as an addition to the interest rate)

$$L = \frac{Y - C(1 + p + r)^n + \sum T_{m_j}(1 + p + r)^{n-m_j} - e \dfrac{(1 + p + r)^n - 1}{p + r}}{(1 + p + r)^n - 1}$$

thus, $$L = \frac{\$14.41 - \$4 + \$2.6658 + \$0 - \$0.05 \times 41.6459}{1.6658} = \$1.00, \text{ and}$$

FORMULA 6 (Including taxes as a separate item)

$$L = \frac{Y - C(1 + p)^n + \sum T_{m_j} (1 + p)^{n-m_j} - X - e \dfrac{(1 + p)^n - 1}{p}}{(1 + p)^n - 1} \quad (1, \text{p. } 559),$$

thus,

$$L = \frac{\$14.41 - \$4 \times 2.0938 + \$0 - \$3.12 - \$0.05 \times 36.4593}{1.0938} = \$1.00.$$

The next step is the determination of formulas expressing the tax cost, X. Since the tax equals the tax rate times the value, the first year's taxes $= rV_0$, the second year's tax $= r \left[V_0(1 + p + r) + e\right]$, the third year's tax $= r \left[V_0(1 + p + r)^2 + e(1 + p + r) + e\right]$, and so on. Since the first year's tax is paid at the end of the year, it will be compounded at the interest rate, p, through each of the

remaining years of the income cycle after the first or in all n—1 years, to obtain its value at the end of the income cycle, that is $rV_0(1+p)^{n-1}$. The next year's tax will be compounded for n—2 years, $r\left[V_0(1+p+r)+e\right](1+p)^{n-2}$, etc.

Summing all of these individual expressions and using the proper simplification, the formula for the total tax cost may be derived.

FORMULA 7 (With V_0 given, assumed to be justified by an unknown yield)

$$X = V_0\left[(1+p+r)^n - (1+p)^n\right] + \frac{e}{p+r}\left[(1+p+r)^n - (1+p)^n - r\frac{(1+p)^n-1}{p}\right] - \sum T_{m_j}\left[(1+p+r)^{n-mj} - (1+p)^{n-mj}\right].$$

thus,

$$X = \$5(2.6658 - 2.0938) + \frac{\$0.05}{.04}\left[2.6658 - 2.0938 - .01 \times 36.4593\right] - \$0 = \$3.12.$$

Formula 8 gives an expression for the cost of taxes in terms of the expected yield, Y—C, which is assumed to be in balance with the initial forest value, V_0.

FORMULA 8 (With Y—C given)

$$X = Y - C + \sum T_{m_j}(1+p)^{n-mj} - \left[Y - C + \sum T_{m_j}(1+p+r)^{n-mj}\right] \times \left[\frac{(1+p)^n-1}{(1+p+r)^n-1}\right] - \frac{re}{p+r}\left[\frac{(1+p)^n-1}{p}\right] \text{ (1, p. 59).}$$

$$\text{thus, } X = \$10.41 + \$0 - \left[\$10.41 + \$0\right]\frac{2.0938-1}{2.6658-1} - \frac{.01 \times \$0.05}{.04} \times 36.4593 = \$3.12.$$

The complete derivation of formula 8 has already been published (1, pt. 3).

Formula 9 is useful if it is desired to estimate the value of an immature forest at the end of the qth year of the rotation. Intermediate incomes may be received between the qth and the nth years.

FORMULA 9

$$V_q = \frac{Y + L + \sum T_{m_j}(1+p+r)^{n-mj} - e\,\dfrac{(1+p+r)^{n-q}-1}{p+r}}{(1+p+r)^{n-q}}.$$

If q = 15 years (refer Table 1), then

$$V_q = \frac{\$15.51 + \$0 - \$0.05\,\dfrac{1.04^{10}-1}{.04}}{1.04^{10}} = \$10.01.$$

Formula 10 gives an expression for the cost of taxes for the period n-q years when Y + L at n years is given.

FORMULA 10

$$X_{n-q} = Y + L + \sum T_{m_j} (1 + p)^{n-m_j} - \left[Y + L + \sum T_{m_j} (1 + p + r)^{n-m_j} - e\,\frac{(1 + p + r)^{n-q} - 1}{p + r} \right] \frac{(1 + p)^{n-q}}{(1 + p + r)^{n-q}} - e\,\frac{(1 + p)^{n-q} - 1}{p},$$

thus, if $q = 15$ years (refer Table 1), $X_{n-q} = \$15.41 + \$0 -$

$$\left[\$15.41 + \$0 - \$0.05\frac{1.4802 - 1}{.04} \right] \frac{1.3439}{1.4802} - \$0.05 \times 11.4639 = \$1.39.$$

The cost of taxes could also be determined by substituting V_q as found by formula 9 in place of V_0 and n-q for n in formula 7.

It should be emphasized that formulas 1-10 (except 5 and 6) relate to both even-aged (single-age-class) and uneven-aged (selection or series of even-aged stands) forests. Thus in a single-age-class forest the income cycle, n, equals the rotation period. The cost of regeneration, C, will occur at the end of the income cycle—rotation period. Theoretically the initial forest value, V_0, in an even-aged forest will be equal to the initial cost of the land, L, plus the cost of regeneration, C.

In an uneven-aged forest the income cycle, n, is a period less than the rotation. There may be two or more income cycles in each rotation and they may be regular or irregular in length depending upon the number and distribution of age classes in the forest. Any cost of regeneration will occur at the end of the income cycle and will, in theory, be paid out of receipts at that time. An uneven-aged forest may be considered a selection forest, in which case the series of age classes is represented by regular gradation of ages among individual trees, or it may be regarded as composed of a regular series of even-aged stands. The initial forest value, V_0, in an uneven-aged forest is the value of the land, L, plus the value of the growing stock at the beginning of the income cycle. For an uneven-aged forest the land value, L, is the land value of the corresponding even-aged forest having the same rotation period and yield and would be determined from formulas 6 and 7 using such rotation period and yield. Intermediate incomes may be received during the period of an income cycle in either an even or uneven-aged forest.

Formulas Applicable to Sustained-Yield Forests

A forest operated under annual sustained yield management is treated by the property tax on the same basis as other forms of property yielding an annual income. Taxes, as well as other expenses, are paid out of income annually and no period of deferment is involved. The annual tax cost is found by multiplying the value at the beginning of the year by the tax rate. This value is the capitalization at the tax and interest rate of the total yield less regeneration costs and expenses other than taxes. Thus, with a value at the beginning of the year, V_0, the tax to be paid at the end of the year will be rV_0. The value increment will be $pV_0 + rV_0 + e$, or $V_0(p + r) + e$. Since under annual sustained yield the gross income will equal the value increment $V_0(p + r) + e$, the subtraction of this expression from $V_0(1 + p + r) + e$, the value at the end of the year brings the value back to V_0. The tax costs and other expenses do not add to the capital investment since they are incurred simultaneously with the receipt of income and so are written off at that time.

FORMULA 11 (In terms of initial value)

$$X = rV_0 \quad (1, \text{p. } 53).$$

If the value at the beginning of the year is \$15.41 (Table 1 assuming sustained yield at the 25th year) then $X = \$15.41 \times .01 = \$0.154$, or,

FORMULA 12 (In terms of Y)

$$X = \frac{r(Y - C - e)}{p + r} \quad (1, \text{p. } 51).$$

The yield, Y, and taxes paid at the end of the 26th year (See Table 1) may be estimated as follows (no regeneration cost included):

\$15.41 × 3 per cent = \$0.463 interest on initial value,
\$15.41 × 1 per cent = \$0.154 taxes, thus increase in value
equals: \$0.463 + \$0.154 + \$0.05 (expenses) = \$0.667.

By formula 12:

$$X = \frac{.01(\$0.667 - \$0.05)}{.04} = \$0.154.$$

Under sustained yield the initial value, \$15.41, and the taxes, \$0.154, will, in theory, remain the same for each subsequent year.

Formulas Applicable to Old-Growth Forests Being Depleted

An old-growth forest will be depleted if the cutting takes place faster than the growth occurs. This depletion may be complete, in which case the forest is devastated by the removal of all the growing stock, or it may be partial to reduce the mature and over-mature growing stock to an annual or periodic sustained yield basis. Depletion may be by annual or periodic cuts equal or unequal in amount over a period of years, or by cutting the entire forest in one year. The land may be disposed of either by sale or abandonment at the time the forest is removed, it may be held and a new forest established, or held and sold en bloc at the k period. The operator's decision is affected by the estimated difference, at various periods in the future, between the total cost of holding the timber and land and the expected price (1, p. 534).

The present value at the beginning of a period of depletion of an old-growth forest is designated V'_0 to distinguish it from the initial forest value V_0. In formula 13, d = the annual income of a depletion forest excluding land, $\frac{L}{k}$ = annual receipt from the sale of land, k = period of depletion and e = expenses decreasing each year by $\frac{e}{k}$.

FORMULA 13 (With an annual receipt from land)

$$V'_0 = \frac{\left(d + \frac{L}{k} - e\right)\left[(1 + p + r)^k - 1\right]}{(1 + p + r)^k\,(p + r)} + \frac{e}{(p + r)\,(1 + p + r)^k} \times \left[\frac{(1 + p + r)^k - 1}{k(p + r)} - 1\right]$$

If the land were abandoned after the removal of the timber the factor $\frac{L}{k}$ would not be included and V'_0 would represent the present value of the timber only. The expenses in formula 13 are assumed to decrease progressively with the depletion of timber and land. Should it be desirable to estimate a constant average annual expense instead of a decreasing one then the last term of formula 13 would be omitted in determining V'_0.

Solving in formula 13 for d, the equal annual income before taxes exclusive of land value would be:

FORMULA 14

$$d = \frac{\left[V'_0(p+r) + e\right](1+p+r)^k}{(1+p+r)^k - 1} - \frac{1}{k}\left(L + \frac{e}{p+r}\right).$$

In the case of unequal annual receipts if the variations are small and neither markedly progressive nor regressive an annual average may be estimated and formula 13 used. If equal or unequal periodic receipts and equal annual expenses for the same period are expected the present value may be determined by summing the discounted future net incomes to the present time. That is:

FORMULA 15

$$V'_0 = \frac{d_1 + L_1 - e_1\dfrac{(1+p+r)^{k1}-1}{p+r}}{(1+p+r)^{k1}} + \frac{d_2 + L_2 - e_2\dfrac{(1+p+r)^{k2-k1}-1}{p+r}}{(1+p+r)^{k2}} + \frac{d_3 + L_3 - e_3\dfrac{(1+p+r)^{k3-k2}-1}{p+r}}{(1+p+r)^{k3}} + \ldots,$$

where d_1, d_2, d_3, . . . are periodic receipts from the sale of timber at k_1, k_2, k_3, . . . years from the beginning of the operation; L_1, L_2, L_3, . . . are periodic receipts from the sale of land at the time of the periodic receipts, and e_1, e_2, e_3, . . . are anual expenses during the periods of k_1 years, k_2-k_1 years, k_3-k_2 years, ...

Tax costs for the period of depletion, assuming equal annual sale of both timber and land, may be estimated by formula 16.

FORMULA 16 (With equal annual income from sale of timber and land)

$$X_1 = V'_0\left[(1+p+r)^k - (1+p)^k\right] - \frac{d + \frac{L}{k} - e}{p+r}\left[(1+p+r)^k - (1+p)^k - r\frac{(1+p)^k - 1}{p}\right] - \frac{e}{k(p+r)^2}\left[(1+p+r)^k - (1+p)^k - \frac{r(2p+r)}{p}\cdot\frac{(1+p)^k - 1}{p}\right]$$

In formula 16 it has been assumed that the annual expense decreases annually by $\frac{e}{k}$. If a constant average annual expense is used instead of a decreasing ex-

pense, then the last expression in formula 16 will be omitted. The factor $\frac{L}{k}$ would not be included if the land instead of being sold were abandoned.

The amount of tax savings at the k period through depletion as compared to holding the forest intact could be estimated by subtracting the amount of taxes found by using formula 16 from the tax cost as found by using formula 7.

As before stated the land left after cutting an old-growth forest may be held either for sale en bloc at the end of the depletion period, k, or it may be held for additional forest production. The value of the forest, V_k, in the latter case, assuming that the land is immediately reforested after cutting and an annual expense, $\frac{e}{k}$, is incurred for each part cut, would be:

FORMULA 17

$$V_k = \frac{(L + C)[(1 + p + r)^k - 1]}{k(p + r)} + \frac{e}{p + r}\left[\frac{(1 + p + r)^k - 1}{k(p + r)} - 1\right].$$

However, if the land is held until the end of the period, k, (but no cost of regeneration is incurred) at which time it is sold as a unit, formula 17 would still apply but C and e would each be equal to zero.

Solving the preceding equation for the land value,

FORMULA 18

$$L = \frac{k[(p + r)V_k + e]}{(1 + p + r)^k - 1} - (C + \frac{e}{p + r}).$$

In the case where the land is held after the depletion of the timber for additional forest production, the property taxes during the period of depletion, k, would be paid on the land and standing timber until cut and on the bare land value after cutting, plus the annual increase in value due to the cost of regeneration, annual expenses and interest. The sum of taxes plus interest to the end of the depletion period could be estimated by formula 19 which is a special case of formula 7.

FORMULA 19

$$X_2 = V'_0\left[(1+p+r)^k - (1+p)^k\right] + \frac{(C+e-d)}{p + r}\left[(1+p+r)^k - (1+p)^k - r\frac{(1 + p)^k - 1}{p}\right]$$

An old-growth forest may be cut in such a manner as to insure the conversion of the forest to sustained yield, either annual or periodic. If it is assumed that an old-growth forest is depleted for a number of years, k, at which time annual sustained yield management is made possible on the basis of the residual stand, the value, V_k at the end of k years will be the capitalized annual net income at the pure interest rate.

The present worth of the forest at the time depletion begins would be the present worth of V_k plus the present worth of the annual receipts as determined by the use of the annuity formula. Formula 9 may be used where Y + L would be

replaced by V_k as determined above, $(n - q)$ by k, and the equal annual receipts, T_1, T_2, T_3, etc., from timber depletion would take the form of an annuity for k years.

An old-growth forest which is financially immature may be held for a period of years and then depleted. Taxes, interest, and expenses are costs which continue until the timber is disposed of. To determine the taxes for the period of holding, formula 8 will be applicable where n is the period of holding. For determining V'_0 formulas 3 or 4 would apply with the change that the -1 in the denominator would be omitted due to the noncyclic character of the old-growth forest income.

The preceding formulas have been presented as an aid to estimating the present and future value and the tax costs on forests under various conditions. They serve as an analytical guide and a check when this kind of information is needed. Obviously their value for practical purposes is dependent upon their use in conjunction with sound reasoning and experience. A complete understanding of the derivation of the formulas is not essential to their use. Notwithstanding their somewhat complicated appearance, a little study will disclose the ease with which they may be used in the ordinary problems of forest finance and taxation.

It is assumed that in the use of the foregoing formulas a separate deduction from gross receipts for the cost of administering sales when they occur will be made. that allowances will be made for federal and state income and death taxes, business and corporation taxes and similar commitments (1, pp. 405-419), and that consideration will be given to trends in stumpage prices and fluctuations in the value of money.

Glossary of symbols and their definitions used in the foregoing formulas:

$V_0 =$ Initial forest value at beginning of income cycle of a deferred yield forest.

$V'_0 =$ Present worth at beginning of period of liquidation of a depletion forest.

$V_q =$ Present worth of an immature forest at the end of the qth year of the rotation.

$V_k =$ Value of forest at end of depletion period—land having been reforested immediately after cutting.

$L =$ Land or soil expectation value.

$C =$ Cost of natural or artificial regeneration.

$X =$ Sum of taxes during an income cycle with compound interest at p rate to end of cycle.

$X_{n-q} =$ Sum of taxes from qth year to the end of the income cycle with compound interest at p rate to the end of cycle.

$X_1 =$ Sum of taxes with compound interest at p rate from beginning to end of liquidation period, both land and timber liquidated.

$X_2 =$ Sum of taxes with compound interest at p rate to end of liquidation period, land continued in forest production.

$Y =$ Major income received at end of income cycle.

$Y - C =$ Major income received at end of income cycle less cost of regeneration.

$p =$ Pure interest rate (risk and tax free).

$r =$ Tax rate on actual value at beginning of year, taxes payable at end.

$T_{m_1}, T_{m_2}, \ldots =$ Income from thinning, etc., at intermediate preiod, $m_1, m_2, \ldots$ years from the beginning.

$\sum T_{m_j}(1+p)^{n-m_j}$ and $\sum T_{m_j}(1+p+r)^{n-m_j} =$ Sum of incomes from thinnings, etc., each income compounded to the nth year at p and $p+r$ rates respectively.

$e =$ Annual administrative expenses (other than additional cost if any, for administering sales).

$n =$ Number of years in income cycle.

$q =$ Number of years elapsing from the beginning of income cycle to some point in time at which value of forest is desired.

$k =$ Period of depletion of an old-growth forest.

$d =$ Equal annual net income of a depletion forest before taxes, excluding land.

$k_1, k_2, k_3, \ldots =$ Number of years elapsing from the beginning of depletion period to receipt of periodic incomes.

$d_1, d_2, d_3, \ldots =$ Periodic incomes of a depletion forest before taxes, excluding land, at periods $k_1, k_2, k_3, \ldots$

$L_1, L_2, L_3, \ldots =$ Land depleted at $k_1, k_2, k_3, \ldots$ periods.

$e_1, e_2, e_3, \ldots =$ Annual expenses during periods k_1, k_2-k_1, k_3-$k_2, \ldots$ years.

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FERNOW HICKORY (*Hicoria fernowiana* Sudw.)

By W. A. DAYTON

U. S. Forest Service

Hickory nomenclature is much confused. The genus needs correlated study by competent persons from the systematic, ecological, genetic, and economic standpoints. This paper contributes its bit toward the clarification of this complex problem. Its author has recently rediscovered in Washington, D. C., the type tree of *Hicoria fernowiana*, a long-forgotten species of the late Mr. Sudworth. It is probable that much of the "nutmeg hickory" of literature is misnamed and is, in part at least, Fernow hickory.

NO group of American trees is in greater taxonomic confusion than hickories. An American dendrological quartette, all deceased within the past decade—Ashe, Britton, Sargent, and Sudworth—are responsible for all (or practically all) our *Hicoria* names, specific, subspecific and varietal, but only Britton (2) and Sargent (7, 8) have attempted to monograph the genus. Their generic outlines, however, can be fairly designated at this date either as too antiquated or too sketchy to be satisfactory. For example, no one appears ever to have made an adequate study of field variations of hickories due to ecological conditions. Again, although the study of type specimens is basic to a scientific monograph worthy of the name, it is extremely doubtful if any taxonomist ever has studied the type specimens of our hickories, many of which are doubtless in foreign herbaria. Hickories are well worthy of a combined attack from the systematic-morphological, ecological, cytological-genetic, and economic standpoints. Until adequate finances and personnel are available for such a thorough genus-wide study, there is a definite place for papers on various aspects of individual forms.

In a 46-year-old pamphlet entitled *Trees of Washington, D. C.*,[1] by Geo. B. Sudworth—so obscure that it had not been listed hitherto in the card indices of the libraries of the U. S. Department of Agriculture or of the Forest Service—the writer recently discovered the original diagnosis of a hickory tree, by the late Mr. Sudworth, not mentioned in his two later check lists (11, 12) and cited only as a synonym in his first list (10). This description is as follows:

"*Hicoria Fernowiana* (sp. nov.), Sudworth. Leaflets 7-9, 4-7 in. long, 1-2½ in. wide; lower pairs slightly falcate, inequilateral subsessile; margin closely serrate, with small more or less appressed teeth; smooth; upper surface dull green, punctate; lower surface pale silvery green, with age becoming coppery: leaf-stems and branchlets similar, but scurfy; buds tawny. Immature fruit orbicular, with thin shell and husk, the latter strongly winged at the sutures. Bark smooth. Resembles H. minima, Marsh. A single tree (now 25 ft), supposed to have been brought from the South, was planted in Department Grounds about twenty-five years ago."

No type specimen of *Hicoria fernowiana* is on deposit in the type collection of the U. S. National Herbarium. Mr. Sudworth's original description makes no mention of a herbarium type and it is doubtful if one was made. By a stroke of good fortune, however, this description

[1]This pamphlet also bears on its cover the words "Compliments of the Forestry Division" and a monogram (which appears to be "A.A.A.S."), with the date "1891." Dr. Henry B. Ward, Secretary of the American Association for the Advancement of Science, writes me, under date of February 11, 1937, that the A.A.A.S. met in Washington in August 1891, but that Association records do not mention this tree booklet. The brief preface of this work seems clearly to intimate that it was intended primarily for botanists attending that convention.

contains a diagram of the Department of Agriculture grounds, with the sites of the trees Mr. Sudworth mentions marked thereon. Using this diagram as guide, the writer feels confident that, despite the "face-lifting" to which the Mall section has been subjected in recent years, he rediscovered last autumn the type tree of *Hicoria fernowiana* Sudworth. He proposes to translate this name, for purposes of the vernacular, into Fernow hickory, honoring as Mr. Sudworth intended, one of the most illustrious names in the forestry profession, Dr. B. E. Fernow, father of forestry and first head of the first forest school in each of two great countries: the United States and Canada.

The tree referred to is located in the Mall, south of the Department of Agriculture greenhouses, about 450 feet south and 175 feet east of the southeast intersection of Constitution Avenue and 14th Street, N. W., Washington, D. C. In the regrading of this area the tree, presumably because of its size and beauty, fortunately has been preserved by building a stone "well" around it, about 2 feet deep. The tree has dark gray, rather flaky bark on the main trunk and branches, the younger branches having smooth and slaty bark. The circumference, breast high from the ground surface, is nearly 6 ft., 8 in. The tree is at least 45 feet high; its general habit is excurrent but the bole is forked about 20 feet above the ground, though one of these branches has become the leader. The lowest branches are first upcurved and then strongly downcurved; the upper branches are ascending or ascending-spreading.

In response to an inquiry as to the name of this tree in the official records, A. H. Hanson, Landscape Architect of the National Park Service, Department of the Interior—which bureau has charge of the public parks in Washington, D. C.—writes me (in part) under date of December 12, 1936:

"This tree is a Nutmeg Hickory, th only one of its kind that I know of. I Bailey's it is listed as Carya myristica formis, but as Standard Plant Names lists Carya as Hicoria, I believe the correc botanical name should be Hicoria myris ticaeformis. The impression I have that this tree is one of a very few any where in the United States.

"It was several years ago that this tre attracted my attention from strictly landscape point of view. I admired it stately upright form and its rich dar green foliage. In investigating, I foun that a special reference to this particula tree was made in Sargent's Silva of Nort America, Vol. VII, Note 6 (8-W.A.D.) a the bottom of Page 146. It was at tha time about 25 feet high, and this boo was published in 1895. I do not own thi volume myself so cannot quote directl from it, but these are the notes I mad at the time I referred to it."[2]

It will be observed from the foregoin and from Miss Keplinger's drawing (Figs. 1 and 2) that Mr. Sudworth's description fits this type tree pretty well The leaves, however, occasionally bea only 5 leaflets (7 is probably the mos usual number) and the lowest pair o leaflets is frequently somewhat dwarfe and about 2½ inches long. As the leave unfold, their lower surfaces present beautiful silver sheen. The bud scales ar valvate. The 3-clustered staminate catkins are pendulous from near the base o the season's twigs on a well-develope common stalk on which the pair of latera catkins are almost sessile; the lowest an best developed catkin itself is conspicuously peduncled. The staminate flower have a well-developed bract and bea

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[2]I am much indebted to Mr. Hanson for first calling this reference to this particular tre to my notice. Sargent's note referred to is:

"A Nutmeg-Hickory tree, which has been growing for many years in the garden of the Depart ment of Agriculture in Washington, is now about twenty-five feet high."

Fig. 1.—*Hicoria fernowiana* Sudworth. A, Flowering spray, with small pistillate flower and conspicuous, pendulous, triramous staminate aments produced from near base of season's growth; B, pistillate flowers, showing bract and 4-lobed and ridged calyx, or involucre; C, bracted calyces of staminate flowers; D, staminate flowers, with stamens and bracted calyces. Drawn by Miss Elnor Keplinger, U. S. Forest Service, from specimen collected May 6, 1937.

Fig. 2.—*Hicoria fernowiana* Sudw. A, Fruiting spray; B, nut, with horizontal and vertical cross-section; C, detail of peltate, lepidote scales (magnified). Drawn by Miss Keplinger from specimen collected Oct. 27, 1936.

about 4-7 stamens with greenish or greenish-yellowish anthers. The involucre of the pistillate flower is conspicuously 4-ridged and this characteristic persists in the strongly winged fruit. The husk is relatively thin. The nut is rather pecan-like in appearance and, including the mucronate tip, about $1\frac{1}{8}$ inches long. The kernel, united at the base and with the tips free, is sweet and has an excellent flavor. The tree's nut crop in 1936 was prolific.

As hitherto mentioned, Sargent (7, vol. 7, p. 145. 1895) and Sudworth (10) have remanded *Hicoria fernowiana* to synonymy under the nutmeg hickory (*H. myristicaeformis* (Michx. f.) Britt., syns. *Juglans myristicaeformis* Michx. f., *Carya myristicaeformis* (Michx. f.) Nutt.). Therefore, it becomes essential to inquire just what *Juglans myristicaeformis* Michx. f. may be. The younger Michaux' brief original Latin diagnosis (6, vol. 1, p. 211. 1810) of this species, which he calls "The nutmeg hickery nut" and "cette espèce de Noyer Hickery," is as follows:

"Juglans myristicaeformis, foliis quinis; foliolis ovato-acuminatis, serratis, glabris. Fructu ovato, scabriusculo, nuce minima, durissima."

Michaux (loc. cit., p. 212), in his own mother tongue, further describes the nuts of *J. myristicaeformis* as follows:

"La coquille est tellement épaisse, qu'elle compose plus de deux tiers de leur grosseur; aussi ces noix sont elles d'une dureté extrême, et ne contiennent qu'une amande fort petite; enfin elles sont encore inférieures à celles du *Juglans porcina*."

Michaux says nothing about the husk being winged and his illustration clearly shows no wings on the fruit. Obviously, his description of the nuts does not fit Fernow hickory.

To throw, if possible, further light on this subject (and especially to ascertain if the type specimen has winged fruits), I wrote Prof. H. Humbert of the Museum National d'Histoire Naturelle, Paris, and, under date of March 19, 1937, have received the following reply from him:

"Je regrette vivement de ne pouvoir donner satisfaction à votre demande au sujet de l'Hicoria myristicaeformis Michx. f.

"Nous avons en effet un herbier Michaux précieusement conservé ici et très consulté par vos compatriotes; mais c'est l'herbier du Flora boreo-americana uniquement et le Carya en question n'y est pas; du reste il n'y a jamais dans cet herbier du fruits volumineux. J'ai fait rechercher ce qu'il y aurait dans l'herbier Elias Durand; un échantillon feuilles et fleurs mâles seulement.

"Il m'est donc impossible de vous aider à résoudre la question du type de cette espèce."

Note Professor Humbert's reference to the deposition of Michaux' type of *Juglans myristicaeformis* in that portion of the Paris Museum's collections known as "l'herbier Elias Durand", and his description of it as a staminate spray, without nuts. It is of interest to add that Mrs. Agnes Chase has recently published a paper (3) on the very important but little known Durand herbarium.

At first blush it may seem presumptuous on my part to dispute the findings of two pre-eminent American dendrologists, Sargent and Sudworth, with respect to the scientific name of this hickory; more especially so, because they have passed to the Elysian Fields and are not here to defend themselves. However, the evidence seems conclusive that they were in error in this respect, and (what is scientifically far more important) the correction of this error is one of the many essential steps which must be taken in clarifying the botany of hickories.

The main findings and conclusions of this paper may be summarized as follows:

1. The type tree of Fernow hickory (*Hicoria fernowiana* Sudw.) has been rediscovered.

2. *Hicoria fernowiana,* whatever its origin may eventually prove to be, seems to be a valid and distinct species, allied to pecan. Fernow hickory is recommended as its English name.

3. Field studies are needed to determine the range, distribution, abundance, life history, economic value, etc., of Fernow hickory. It is not unlikely that it will prove a valuable species—rather widely distributed and not rare.

4. The "nutmeg hickory" ("*Hicoria myristicaeformis*") of much of our late dendrological literature is probably Fernow hickory. For example, Coker and Totten's *H. myristicaeformis* (4) perhaps may be *H. fernowiana,* at least in part. Small's *H. myristicaeformis* (9), in view of his English name "bitter-waternut", may possibly be true *H. myristicaeformis,* in part, though the fruits are described as winged. The economic and other notes for *H. myristicaeformis* given by Boisen and Newlin (1) and Detwiler (5) may also apply to *fernowiana* pro parte.

5. The original description (under *Juglans*) of *Hicoria myristicaeformis,* by the younger Michaux, is radically different from that of *H. fernowiana* Sudw., a fact corroborated by an examination of the type tree of *H. fernowiana* itself. Therefore, *H. fernowiana* cannot be a synonym of *H. myristicaeformis.*

6. The writer has not had the privilege of visiting the Durand herbarium in Paris, where Michaux' type of *Juglans myristicaeformis* is reported to be located, but has a note from Prof. H. Humbert about it. That species is originally described as having typically five, ovate-acuminate leaflets, a small inedible nut (bitterer even than that of pignut), and Michaux' beautiful companion plate (Pl. 10, *op. cit.*) shows a fruit wholly devoid of wings.

7. It is of prime importance, in publishing data on plants, that the species referred to be determined as accurately as possible. This is particularly true hickories, in view of their complicat nomenclatural status.

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EASTERN RED CEDAR

By M. E. JELLEY

Resettlement Administration

Eastern red cedar (*Juniperus virginiana*) is an important timber tree in many sections of the United States. To date, very little work appears to have been done on the production of red cedar planting stock or the silviculture of this tree. In the following paper the importance of red cedar in Tennessee is described and the results are given of some experimental work on hastening red cedar seed germination.

THE Resettlement Administration, of the U. S. Department of Agriculture, has acquired large areas of worn-out agricultural lands and stripped timber lands which are located ten miles south of Lebanon, in central Tennessee. This town received its name because of the close resemblance of the red cedar in the vicinity to the Cedars of Lebanon of Biblical history. The project is called the Lebanon Cedar Forest because of its location near the town of Lebanon and the large number of red cedar trees that grow exceedingly well over practically the entire tract. Studies by the Resettlement Administration indicate that this land should revert to forests and that red cedar, as in the past, must be considered the important timber tree.

The abandoned farm lands must be reforested and the heavily grazed open timber tracts must be reinforced with red cedar. There are 7,750 acres in the Lebanon Forest which should be planted largely to red cedar. Approximately 5,000,000 seedlings will be needed to complete the work. But no red cedar forest planting stock has been grown by commercial nurseries and collected planting stock, commonly called "wildlings", is too expensive and the results with it are unsatisfactory.

Faced with these conditions the Resettlement Administration either had to undertake the production of red cedar planting stock or to ignore this important timber tree which is so well adapted to the region. It was decided to grow planting stock and a nursery now has been established.

Because the importance of red cedar as a timber tree has not been fully recognized by foresters, it is worthy of mention that this tree has been given credit for bringing more money into the state of Tennessee than any other species of timber tree. It is probably the only tree for which there is a steady market for wood of all sizes from one and one-half inch bean poles upward. The durability of its wood ranks with that of black locust. The tree is comparatively free from attack by insects and fungi. Stumpage values during the past fifteen years have ranged from $15 to $30 per thousand board feet, depending upon logging conditions. The superiority of red cedar lumber for closet linings, cedar chests, pencil slats, etc., is well recognized. Exceedingly close utilization can be practiced with red cedar because of the demand for small dimension stock, and the ability of the cedar oil industry to utilize all parts of the tree, including the saw dust and stumps. Split rail cedar fences that have been in use for seventy-five years are eagerly purchased for pencil slats at $14 per ton. Old cedar log buildings that were constructed more than a century ago are sought out, purchased, and the logs cut into cedar boards and pencil slats.

Cedar adapts itself well to most all types of soil and thrives on very rocky

ledges where other trees cannot exist. It will grow on areas that are too dry and barren to produce other trees of commercial importance. Red cedar in the vicinity of the Lebanon Cedar Forest reaches thirty-six inches d.b.h. and a height of eighty feet. An eight-inch stick, six feet long, is considered a saw log.

Approximately six hundred pounds of treated red cedar seeds have been planted in nursery beds following usual nursery practices. Various quantities have been sown per square foot, different amounts of fertilizer have been used and full sunlight to fifty per cent shade have been provided. All indications point to successful germination of the seed. If this is secured information will be available on which to base the quantities of seed to be sown following various kinds of treatment. Through other experimental work we hope to determine methods of producing seedlings in quantities at reasonable prices, the planting stock age best suited for reforestation, the best spacing and mixtures, planting methods, and other details which will promise reasonable success in artificial reforestation. During the fall of 1936 a total of 1,175 pounds of red cedar berries were collected. The seeds were treated in many ways that seemed to promise success in causing an after-ripening and breaking down of the hard seed coat so that germination would be secured in one year. The most successful of these experiments are described.

Cedar berries were frozen in a block of ice and permitted to remain for a period of twenty-one days. At the end of this period the ice was placed on a canvas, permitted to melt and the seeds were depulped. After this treatment, five pounds of cedar berries were found to yield one pound of clean seeds. These seeds were kept moist and at the end of thirty-five days germination started. On the forty-fifth day a rag doll test indicated that the percentage of germination had reached 56.2 per cent.

In another experiment seeds we cleaned by running them through a wrin er and working them through a small wi mesh. These seeds were stratified in pe moss and placed in a refrigerator at temperature of 41° F. for a period sixty-six days. They were kept moist all times and at the end of this peri sixteen per cent germination was secure It is probable that a larger percentage seeds would have germinated if permitt to remain under these conditions a long time, but the seeds that germinated fi would undoubtedly have been injured that they could not have been successful planted. When these seeds were sown larger percentage of germination result immediately.

Another experiment was based upon t general understanding that red cedar see will germinate immediately after passi through the digestive tract of a bird. the vicinity of the Lebanon Cedar For millions of robins have found their win haven each year and seedlings have g minated abundantly beneath these rol roosts. An effort was made to produ the same effects artificially. One gall of one-half of 1 per cent solution hydrochloric acid was secured and o ounce of pepsin was added. These reported to be the active ingredients o bird's stomach. Clean red cedar seed w soaked in this solution for two hou Then it was removed and soaked in a so tion of one quart of slightly alkaline so tion and one ounce of pancreatin for f hours. This solution is similar to intestinal action of the bird. Seeds trea in this way were stratified in peat m and kept at a temperature of 71° F. a 41° F. At the end of a sixty-day peri the seeds stratified at 71° showed 33.7 cent germination and those stratified 41° F. showed 20 per cent germinati

Still another experiment included scarifying of seeds by scouring them tween two rough surfaces until the se coats were very thin. They were t

oaked in the solution described above for a period of five and one-half hours and tratified in peat moss for a period of ixty days. At the end of the period here was 53.6 per cent germination.

A number of other experiments were onducted with various degrees of success. ome were impractical, both because of he laborous treatment necessary, and the rohibitive expense.

A comparison of the results obtained rom the above experiments indicate the ighest percentage of germination was obained from the seed frozen in a block of ce. The cost of the ice treatment is $1.20 er 100 pounds of berries. A refrigerator quipped to handle an equivalent number f seeds will cost about $225 in addition o the cost of operation. The cost of the cid treatment is comparatively low, but he treatment is complicated and requires onsiderable time and attention. When all actors are considered, it is believed that he most practical and economical method f obtaining rapid germination in one ear may be secured by freezing red cedar erries in ice for a period of twenty-one ays.

Securing germination in one year is nly the first step in solving the difficult problems of quantity nursery production of red cedar. After seedlings have been successfully produced in the nursery and the best method to plant them successfully in the field has been learned, there remain many details concerning the silvicultural methods that will most easily produce cedar forests. The spacing necessary to produce saw logs free from defects is a very important factor because it is known that limbs should not be pruned from these trees. If the limbs are cut close to the trunk they will not heal over. The best method now used where limbs must be removed is to leave a stub from eight to ten inches long.

Everyone familiar with red cedar in central Tennessee recognizes it to be an important timber tree. Foresters cannot evade their responsibility in determining methods of nursery production and silvicultural requirements necessary for its best growth. The Resettlement Administration is endeavoring to do its share of the work. Other foresters and individuals having experience in growing of red cedar are urgently requested to report their experience with the best methods of re-establishing this valuable timber tree.

A TREE CLASSIFICATION FOR LODGEPOLE PINE IN COLORADO AND WYOMING

By R. F. TAYLOR

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Lodgepole pine trees in Colorado and Wyoming are classified into four vigor classes. With little practice these four classes may be readily recognized by external appearances. The differences in the rate of growth of trees in the four classes are highly significant in both uncut and cut-over stands.

THE lodgepole pine stands of Colorado and Wyoming on sites capable of producing merchantable timber lie almost entirely within the National Forests. Ever since the Forest Service was established in these two states the lodgepole pine stands have been under forest management. Mature stands were marked for selection cutting, and cutting cycles were roughly computed with very little growth data as a basis. As the growth was known to be many times the annual cut, lack of accurate growth and yield figures was not a serious matter. Now, however, both the number and size of timber sales are rapidly increasing and although the growth still greatly exceeds the annual cut, over the region as a whole, there are now many small units which must be managed on the basis of more accurate information as to growth and yield, and which must be marked for cutting with a more accurate knowledge of what the individual trees composing the residual stand will do after cutting. As this type of information will soon be necessary for the entire lodgepole pine type in Colorado and Wyoming, growth and yield studies are being started for both the immature, even-aged stands and for the large areas of mature, uneven-aged forests which are cut by the selection system.

Two things are needed in order to increase accuracy in managing the lodgepole pine stands. One is more accurate marking knowledge and the other is more
accurate growth data for predicting fut
cuts and the size of working circles. T
growth and yield tables are made m
accurate by classifying the trees accord
to their growth potentialities. In order
leave the stands in the best possible si
cultural condition after cutting the ma
er must know these tree classificatio
Knowing that for a certain site and a c
tain residual volume per acre he can
tain a certain future rate of growth
leaving a definite percentage of these
classes, he will mark accordingly.

The purpose of marking trees for
logger has always been to leave the st
in the best possible silvicultural co
tion, but often this ideal is lost sight
in the effort to satisfy the buyer. La
it is possible that marking has suffe
from the necessity of using inexperien
C.C.C. crews for this work. The
classification described here will at l
help to systematize marking as inexp
enced men can soon learn the v
classes, and with instructions as to
percentage of vigor classes to mark
leave above or below certain diame
there will be less guesswork involve

It is probably true that the most vi
ous trees are the most resistant to
ease and insect attack and it will
shown that they make the fastest gro
They should therefore make the best
ents for reproduction. By a system
marking that removes the poor v
classes the stand will gradually be
proved in growth rate, resistance to

ease and insect attack. Marking by the tree classification system is merely tree breeding to produce better stock.

With additional work to determine just what constitutes release for each vigor class it should be possible for the marker to know, approximately, what rate of growth to expect of the unmarked trees after cutting. For example, he will try to leave all vigor class A trees, which grow the fastest, and if he cannot release them they will make good growth anyhow. If he can release them, so much the better. He would probably weed out all the D's which are the least vigorous and the slowest growers and mark all C's that cannot be released on 3 sides. He would make every effort to leave all B's and to release them on more than one side. This will be explained in more detail later.

No set of hard and fast rules could apply, for marking is an art and good judgment is needed. Marking can ruin a good stand or set it on the road to silvicultural perfection. The vigor classes are a tool to be used by the marker who, presumably, knows his trade and can learn to use a new tool that will aid him in his work.

Many tree classifications are known but most of them apply to even-aged stands only. Examples are those developed by Kraft (6), Heck (4), Schotte (7), and Craib (1). In 1922 Dunning (2), indicated the need for a classification in selectively-cut ponderosa pine and in 1928 published (3) his now widely used classification for that species. He set up seven classes defined by combinations of factors influencing vigor, the major ones being age, degree of dominance, and crown development. In 1936 Keen (5) reported upon an amplification of Dunning's classification for identifying ponderosa pine susceptible to insect attack in the Northwest. Keen's classification consisted of four age groups, and within each, four vigor classes, a total of 16 tree classes.

Methods Used in Developing a Lodgepole Pine Tree Classification

A classification of conifers based upon actual rate of growth in volume and identified by outer characteristics indicating this rate of growth was assumed to be basically sound. Two factors contributed to making the lodgepole pine classification a simple one. One factor is this: the age range in stands of mature lodgepole pine stands cut by the selection system in Colorado and Wyoming with which the timber marker will have to deal, and which will be used in constructing growth and yield tables for selection stands is such that it is unnecessary to divide the classification by ages. Vigor classes alone are necessary. This will be explained in more detail later. The other factor is that for lodgepole pine trees 8 inches d.b.h. and larger, which are the ones considered in marking, diameter growth is representative of board foot volume growth. In ponderosa pine this would not be true as height is highly correlated with volume growth, but in lodgepole pine the use of height as well as diameter in determining board foot volume increases the accuracy of volume determination less than 4 per cent in the merchantable stands sampled. For this reason diameter growth alone has been used as a basis for assigning test trees to a vigor class.

First, an attempt was made to identify each of the four vigor classes, A, B, C, and D, in a typical merchantable uncut lodgepole pine stand, using Keen's descriptions for ponderosa pine. Ten trees of each vigor class were tagged and an increment core taken from each. In the laboratory, growth in diameter for the past 30 years was measured under a microscope. Growth rates and assigned

vigor classes were compared and the data analyzed statistically. With this information the same trees were again examined and individual trees having growth rates close to the average of the 10 trees in their vigor classes were described. Other trees which apparently had been misclassified were more closely inspected. In many cases defects in the crown were discovered which lowered the tree's vigor class.

This whole process was repeated in 5 different stands, the last 2 trials including over a hundred trees each. The mental image of each vigor class was clearer with each trial and descriptions were improved.

To determine if the relative difference in growth rate found in uncut stands applied in cut-over stands released by logging a test was made on an area logged 19 years ago. Here a slight error was probably introduced as vigor classes had to be estimated as of the time of cutting. Thirty-two trees were selected in each vigor class, 8 released in one quadrant, 8 in 2 quadrants, 8 in 3 quadrants, and 8 in 4 quadrants. The removal, in logging, of one tree within 20 feet of the residual tree, that tree being large enough to compete with the residual tree for water, light, etc., was considered as full release in one quadrant. The removal of 4 such trees on 4 different sides, constituted full release for the residual tree. The process was repeated in a stand cut 22 years ago where nothing remained but vigor clas[illegible] C and D.

As a result of this work and the sta[illegible] tical tests, final descriptions of the vig[illegible] classes were drawn up.

Results

1. *The Vigor Classes.*—The results [illegible] the tests in the 5 uncut stands are sho[illegible] in Table 1.

For each individual test an analysis [illegible] variance was made to determine if [illegible] difference in growth rate of the 4 vig[illegible] classes was real or due to chance. [illegible] each instance the difference was found [illegible] be significant between the vigor clas[illegible] but not significant within them. In ot[illegible] words, for any one stand, the aver[illegible] rate of growth of the A's was hig[illegible] than the rate of growth of the B's (the [illegible] higher than the C's, etc.), but the diff[illegible] ence in rate of growth within the vi[illegible] class was not large enough to be [illegible] nificant. In the first tests individual tr[illegible] were sometimes assigned to the wr[illegible] vigor class, but the last tests showed gr[illegible] improvement in recognizing the true vi[illegible] class of trees. For those interested in [illegible] statistical method the following tables [illegible] given:

Table 2 indicates very significant [illegible] ferences between the average growth r[illegible]

Table 1

AVERAGE D.B.H. GROWTH OF VIGOR CLASSES IN 5 LODGEPOLE PINE STANDS

Stand number	Vigor classes A	B	C	D
	Average d.b.h. growth—50th inches, past 30 years			
1	101.8	78.1	47.0	31.4
2	93.0	52.4	34.4	25.0
3	73.0	59.0	37.0	24.0
4	72.0	66.6	31.36	24.6
5	93.18	58.6	35.35	22.35
Average	86.59	62.94	37.02	25.47

Table 2

SUMMARY OF ANALYSIS OF VARIANCE FOR 5 ST[illegible]

Stand number	Difference within or between vigor classes	Degrees of freedom	Mean square
1	Between	3	9927
	Within	36	703
2	Between	3	9058
	Within	36	386
3	Between	3	4860
	Within	36	206
4	Between	3	10712
	Within	96	196
5	Between	3	21437
	Within	124	199

of the 4 vigor classes and Table 3 shows the actual differences obtained. In Table 3 note the difficulty in trying to tell the C's and D's apart in the first, second, and fourth test. In tests 1 and 2 lack of experience caused the trouble. In test 3 the difference between C and D was cleared up. Test 4 was made by a field assistant who had been drilled a few hours in identifying the vigor classes. His errors occurred in the two hardest comparisons—between the A and B trees and between the C and D trees. In test 5 the assistant correctly identified the classes which were checked in the field by the writer and no changes made. The laboratory core analyses confirmed the identifications.

The vigor class descriptions were made as simple as possible, as the field work indicates very clearly that they cannot be used effectively without practice and knowledge gained by experience. All the "ifs" and "buts" cannot be put into one set of instructions.

In the tests on cut-over areas similar relative differences between the growth rates of vigor classes were found but the actual rates of growth were increased due to release. (Figures 3, 4, 5, and 6.)

2. *Description of Vigor Classes.*—The outline of vigor class A, Figure 1, is used as a basis for tree form comparison. It will be referred to as the ideal outline.

VIGOR CLASS A

Crown area, 55 per cent or more of the ideal outline.

Crown length, 60 per cent or more of the bole length.

Crown vigor, dense, full, of good color and pointed.

VIGOR CLASS B

Crown area, 30 to 55 per cent of the ideal outline of vigor class A.

Crown length, 50 to 60 per cent of the bole length.

Crown vigor, moderately dense, full, of good color, pointed to slightly rounded.

VIGOR CLASS C

Crown area, 15 to 30 per cent of the ideal outline of vigor class A.

Crown length, 40 to 50 per cent of the bole length.

Crown vigor, sparse, bunchy, color poor, never pointed.

VIGOR CLASS D

All live trees of poorer vigor than class C. Includes trees with class A, B, or C outlines but with dying tops or stag heads.

Experience will show that exceptions to these rules occur. For example, there are certain trees with a class A outline but with extremely sparse crowns. The top is pointed and the long, thin branches have an upward twist at the tips. These are usually vigor class A. There are also spear-topped trees with a sharply pointed wide top but short crown length. These are usually class B trees even though the crown is shorter than specified in the descriptions. With practice these excep-

TABLE 3

ACTUAL DIFFERENCES BETWEEN VIGOR CLASSES IN THE 5 TESTS[1]

Vigor class	Difference in d.b.h. growth in 50th inches					Two standard deviations				
	Test 1	Test 2	Test 3	Test 4	Test 5	Test 1	Test 2	Test 3	Test 4	Test 5
AB	23.7	41.0	14.2	5.7[2]	34.6	23.7	17.56	6.42	12.8	6.06
AC	55.8	58.6	36.0	40.9	57.8	23.7	17.56	6.42	12.2	6.25
AD	70.4	68.0	49.4	47.7	70.83	23.7	17.56	6.42	12.9	8.36
BC	31.1	18.0	21.8	35.2	23.2	23.7	17.56	6.42	7.0	6.08
BD	46.7	27.4	35.2	42.0	36.25	23.7	17.56	6.42	8.2	7.82
CD	15.6[2]	9.40[2]	13.4	6.8[2]	13.0	23.7	17.56	6.42	7.0	8.36

[1]Unequal numbers of trees in vigor classes for tests 4 and 5.
[2]Difference less than 2 standard deviations.

tions and others will become familiar to the marker.

3. *The Relation of Age to Rate of Growth.*—It has been stated that age is not a factor in marking lodgepole pine stands. Figure 2 shows the diameter growth rate of the 4 vigor classes over age. It will be seen that in the uncut stands, class D trees less than 106 years of age are growing faster than class C trees over 230 years old, and that class B trees under 130 years old are growing faster than the class A trees over 210 years of age. If the marker cannot distinguish ages by outer characteristics this appears to be a chance for him to leave the wrong trees in the residual stand. According to a statistical analysis of ages encountered in the tests 68 per cent of all the trees the marker encounters will be between 130 and 210 years of age. In th other 32 instances out of 100 he migh make a mistake unknowingly but th chances of his doing so are small. Ac cording to an analysis of the percentag of tree classes found in the stands sam pled there will be, by number, about per cent A's, 24 per cent B's, 46 per cen C's, and 25 per cent D's. Statistical tes show this to be about normal. The aver age stand of 100 trees therefore has total of only 29 trees in the A and vigor classes; only 5 class A's. Sixt eight per cent of them will be betwee 130 and 210 years of age where no mi take in rate of growth would be mad In other words, there will be 8 questio able B's and perhaps 3 questionable A out of 100 trees. If the marker is choo ing between an A and a B he could l

Fig. 1.—Diagram of vigor classes, prepared from photographs.

wrong 3 times out of 100 but he has a 50-50 chance of marking the right one so his chance of a mistake is 1.5 out of 100. Also the chances of having an A near enough to a B to make a choice in marking necessary are small and, in addition, if good marking is practiced few A's or B's will be removed. All this is assuming the same rates of growth after cutting. Figure 3 shows that the A responds to release better than the B. Therefore, in a choice between the two the marker should leave the A.

Figure 2 also shows that vigor class C grows faster after release than vigor class D. The policy undoubtedly will be to remove all the D's and as many class C's as can be disposed of. Although no marked correlation between age and diameter was found, removing the vigor class C trees from the largest diameter downward is apt to remove more old ones that young ones, and if this is done all C trees remaining would be faster growing than any D that might have been left.

4. *The Effect of Release.*—Figure 2

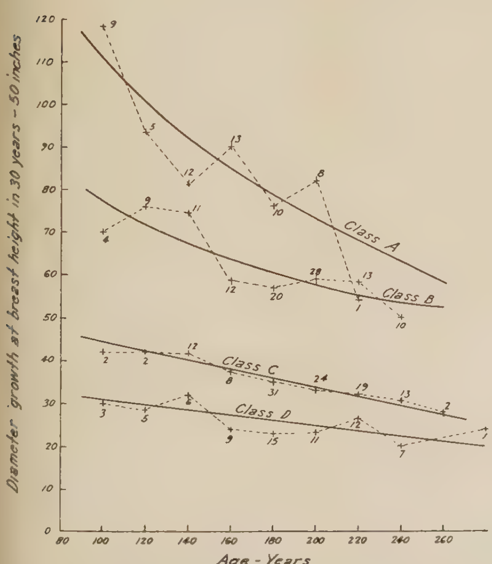

Fig. 2.—Diameter growth of vigor classes according to age. Uncut stands.

shows the effect of average release in a cut-over stand. In Figure 4 the effect is shown by the number of sides, or quadrants released. Further study of release is necessary, and will be made, but a preliminary study indicates that removal of more than one competing tree in a quadrant has little additional effect on the residual tree. The closeness of the curves for B and C trees is probably due to slight mistakes in classifying the trees as of 19 years ago.

From Figure 3 it is evident that residual trees should be released on 4 sides to make the best growth and that the best release for a D results in little better growth than the least release for a C. Table 4 is based on Figure 3.

TABLE 4

RATE OF GROWTH AFTER CUTTING (IN DESCENDING ORDER) BY VIGOR CLASSES AND BY AMOUNT OF RELEASE

Vigor class and number sides released

A 4			
A 3			
A 2			
	B 4		
A 1			
		C 4	
	B 3		
		C 3	
	B 2		
	B 1		
		C 2	
			D 4
		C 1	
			D 3
			D 2
			D 1

In Figure 5 all vigor classes and release classes are thrown together and the total diameter growth by age classes for 19 years shown before and after average release. The point to be emphasized is that growth increase due to release is almost as great in the old trees as in the younger ones, although the actual rate of growth is less for the old trees. The previous discussion of age, however, showed that differences in growth were not great enough to make a division into age as well as vigor classes necessary.

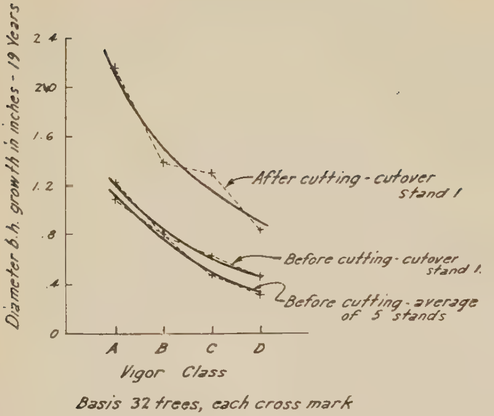

Fig. 3.—Diameter growth of vigor classes before and after release by logging.

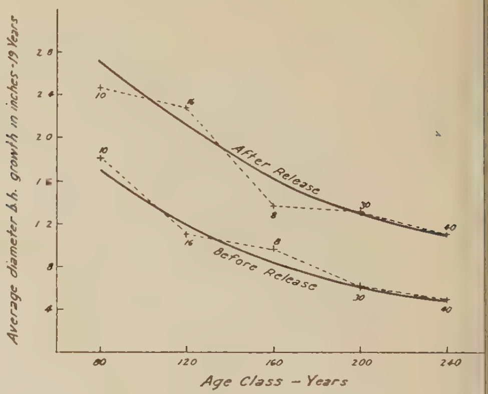

Fig. 5.—Diameter growth of trees before an[d] after release by logging, all vigor classes.

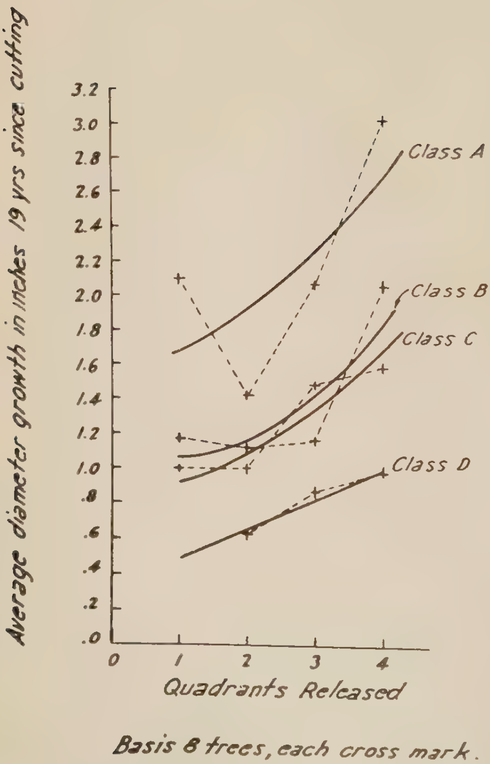

Fig. 4.—Growth rate of vigor classes after release by number of quadrants released.

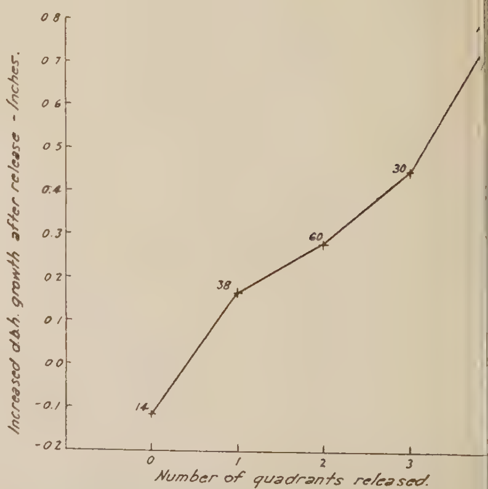

Fig. 6.—The increase in d.b.h. growth 22 yea[rs] after release as compared with 22 years befo[re] release by logging. Class C trees only. Was[h]akie National Forest.

Figure 6 confirms, by data from another area, the less well-defined curves of Figure 4. The decrease in growth of the unreleased trees is probably due to drought conditions during the past few years.

Summary of Results

1. Differences between vigor classes A, B, C, and D as expressed by diameter growth in uncut stands are highly significant each from the other and the classes may be recognized by external appearances with a little practice.

2. In cut-over stands a similar proportionate difference between the growth rate of vigor classes occurs, the A's making the best growth and the D's the poorest. This difference may be further broken down by number of sides released. Table 4 shows the relationships.

3. Age cannot as yet be recognized in mature stands of lodgepole pine from external appearance of the trees, but for marking purposes it is not necessary to separate the trees into age-class groups.

4. The percentages of vigor classes shown to occur in uncut mature stands are probably normal.

5. Diameter growth plotted over age has almost the same trend before cutting as after cutting, with average release. The 200 year-old trees increase their diameter growth almost as much as the 100 year-old trees.

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Delayed Germination in American Elm

Although the seed of American elm (*Ulmus americana* L.) is commonly considered to retain its viability for only a short time, unless placed under controlled storage conditions, an incident has occurred which proves that there are exceptions to this rule also.

At the Lower Michigan Branch of the Lake States Forest Experiment Station located near Roscommon, Mich., during the last week of June 1936, one bed was sown to seed of American elm collected from the current crop at Tawas City, Mich. The seed were sown broadcast on top of the soil (Grayling sand) and then covered to a depth of about one-half inch with sawdust. The bed was kept well moistened until germination was completed. A stand of approximately 80 seedlings per square foot resulted.

In May 1937, before these seedlings had begun to burst their buds, small plants sprouted quite uniformly over the bed between the seedlings already established. It was first assumed that these newcomers were weeds, but their remarkable resemblance to newly germinated elm seedlings prompted leaving them for further development. They have since developed secondary leaves and are, without a doubt, American elm seedlings. These new arrivals average about 20 per square foot of seedbed.

Adjoining beds were sown in the same manner with seed of *Ulmus glabra* Huds., *Ulmus effusa* Willd., and *Ulmus pumila* L. during the first part of July, but none of these species displayed this phenomenon of delayed germination, although the latter two species established good stands.

The causes of this occurrence are subject to conjecture only. The first guess might be that there had been some natural seeding in the American elm bed, but that possibility is eliminated since there are no elm seed trees within several miles and no American elm seedlings appeared this spring in any other beds.

This condition probably was caused by some one, or combination of several meteorological factors which have been somewhat out of the ordinary since these seed beds were established. During early July 1936, new heat records were established for the state of Michigan. At Roscommon there were six consecutive days with maximum temperatures of 100° F. or greater. Then, beginning about August 20, there were abundant rains which produced a wet fall. The winter of 1936-37, too, was unusual. There was insufficient snow to cover the ground more than a small fraction of the time, the maximum depth at any one time being only six inches. On the other hand, much of the winter precipitation came as rain and sleet, and the ground was frozen a good part of the time.

Just how these factors made it possible for about 20 per cent of all the seed (ordinarily of ephemeral viability) which germinated to retain its viability for one year is unknown, but the fact remains that this did occur.

Seed of jack pine, *Pinus banksiana* Lamb., broadcast sown in the field at Roscommon in May 1936, also showed evidences of delayed germination, since about half the seedlings found in a recent count were one year old and the other half newly germinated this spring.

There is a chance here of natural seeding, but a very slight one, since seed traps located on the plot have never caught any seed. The occurrence of delayed germination with this species, however, is not nearly as remarkable as it is in the case of elm, but the same factors are likely to be responsible for both cases.

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THE IMPROVED SARATOGA TREE LIFTING MACHINE

The Saratoga tree lifting machine was first illustrated and described in the JOURNAL OF FORESTRY for April 1935, pp. 439-440. Since that time some changes have been made which have improved materially the value of the machine. The machine is still fundamentally as originally described, that is, the lifting device is attached directly to the tractor itself. In the improved machine, the essential features of which are shown in Figure 1, both the tractor and the lifting device are of stronger construction. The main feature of the lifting attachment is the inclusion of two steel John Deere plow beams, at the lower end of which two "shoes" are attached for holding the blade, from one to the other and at the proper angle. The blade is 64 inches long, 6 inches wide and one inch thick at the back. It is built up of three pieces of iron, forming a more or less "V" shaped blade as viewed in x-section. The upper ends of the beams are attached to an angle iron which is attached to the tractor and serves as a draw-bar. The attachment of the plow beams to the draw-bar is such that the whole lifting devise can be raised or lowered at will. Two handles of pipe are attached parallel with the upper part of the beams. These handles extend directly to the rear while lifting. One man works on each handle, he aids in adjusting the lifter while in operation and uses it to raise the attachment at the end of the row. When the attachment is raised the handles are vertical. The whole attachment is fastened in this raised position, and the tractor is free to move to another row or to any other part of the field. A heavy iron bar attached at the turn of the plow beams helps to hold the attachment in place.

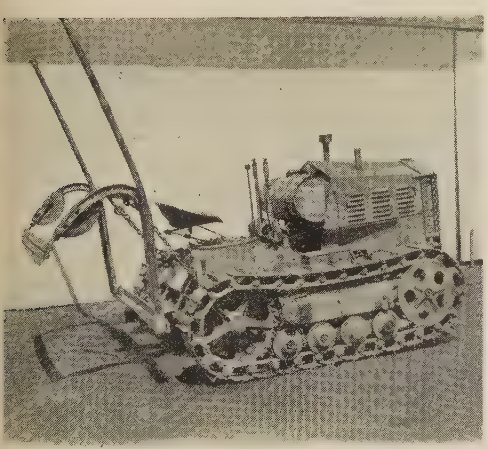

Fig. 1.—The improved Saratoga tree lifting machine.

The tractor used is a model "E" Cletrac, a crawler type with a drawbar horsepower of 22. Experience has shown that this type of tractor with no less horsepower is necessary for satisfactory performance under the variety of conditions. This particular tractor has a clearance between treads of 53½ inches, which is sufficient to straddle the usual 48 inch seedbed. Transplants in rows 10 inches apart are lifted at the rate of 5 rows at a time. The height clearance of the tractor is sufficient to lift four-year transplants up to 15 to 18 inches high. Black locust seedlings up to two feet high are also lifted with ease. There is some "drag" on the tops of these taller seedlings, but no injury was apparent.

The depth of the blade can be regulated by the men on the handles. The blade is so adjusted that the trees are lifted up 2 or 3 inches and then drop

back almost in place again. The soil is therefore little more than loosened and the trees can remain for a day or even longer without danger of drying out. This is of considerable practical advantage since one lifting machine can keep several lifting crews busy at one time, either in transplants or seedbeds, or both.

The cost of the lifting attachment with labor included did not exceed $60. This type of tractor can be used in practically all other operations that are needed about a forest nursery. Other models or makes will probably be as satisfactory as this one. The principal specification being a large enough clearance in width and height.

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N. Y. State Conservation Department.

A Method for Measuring Broken Areas With the Polar Planimeter

In area problems, foresters often find it necessary to eliminate internal areas such as B and C shown in Figure 1. The usual method for finding the net value of the larger Area A is to planimeter B and C separately and to subtract their sum from A. Individual planimeter readings are required involving considerable addition and subtraction.

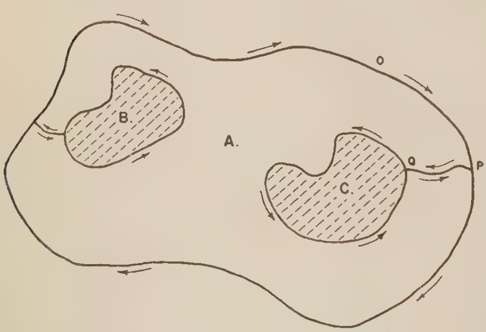

Fig. 1.

However, it is possible to measure the desired area with one reading of the planimeter if the boundaries of the inside areas are joined by connecting lines to the boundary of the outside area. Suppose that the planimeter tracing point was originally at O and that it travels clockwise around the boundary of A until it reaches the point P. It now travels to Area C on the connecting line PQ, goes counterclockwise around the boundary of C, returns to the boundary of A via the line PQ, continues traveling clockwise around A, and repeats the same process for Area B as for Area C. When the tracing point reaches the origin O, the planimeter reading will be the net value of Area A. The inside areas will have been subtracted automatically.

The procedure can be varied somewhat for different problems; for instance, if the internal areas are close together, it may be desirable to join them with a connecting line and to trace out both areas before returning to the boundary of A. By means of connecting lines, it is also possible to include outside areas in the measurement. The tracing point must travel clockwise around outside areas. Rivers and roads, when shown on maps, make good connecting lines.

In using the method described here for measuring broken areas, it is necessary to remember that:

(1) The planimeter tracing point must traverse each connecting line in both directions. The point cannot be lifted from one area to another. The connecting lines should be made as short as possible.

(2) Areas inside the boundary of A must be traced out counterclockwise; areas outside the boundary must be traced out clockwise.

George M. Byram,
Appalachian Forest Experiment Station.

REVIEWS

Headwaters Control and Use. Papers presented at the Upstream Engineering Conference, Washington, D. C., September 22 and 23, 1936. Published by Soil Conservation Service and Forest Service, U. S. Department of Agriculture, with cooperation of Rural Electrification Administration. *xi + 261 pp. Illus. Government Printing Office, Washington, D. C. 1937. Price 60 cents.*

When the *New Republic* describes this as "a third volume in what has come to be one of the most notable series of publications ever issued by the United States government", it is time for those interested in or connected with forestry to realize that that phase pertaining to "influences" is receiving challenging, serious consideration, and is no longer the academic subject it has long been in this country. True, erosion-control activities on the National and State Forests since 1933 have made this a realistic subject to many. Only recently, however, have we begun to see its ramifications and its close tie-up with major engineering projects.

It would be hopeless, within a reasonable space, to attempt even the lightest comment upon each of the papers in this volume, which, although tellingly illustrated, is by no means "padded" with light graphic material. In fact, it is "heavy" throughout, and as the *New Republic* further states, referring to the memorable "series", "'Little Waters' was an elementary exposition addressed to lay readers at large. The 'Great Plains Report' dealt with a specific region and was addressed primarily to public administrators and law-makers. 'Headwaters Control and Use' is a comprehensive treatise for the engineering profession."

We refuse to permit the forestry profession to be omitted. This treatise and all that it implies in technique, organization, and political economy, is a challenge to our profession. And, lest the term "upstream engineering" discourage some foresters with the thought that the engineering profession is about to take over all conservation activities having to do with water, let the breadth of the term be implied by a quotation from Mr. Cooke's article (p. 204):

"And with respect to works themselves —mechanical manifestations of engineering—there must be variety and unity. A beaverlike retarding dam back on a farm creek and a Boulder Dam on a trunk stream are parts of the same complex of engineering. Every device of stream control may have a relation to every other device, but all dams do not have to be of concrete with a metal core. Stone, rubble, logs, and litter have each a part to play."

The book is divided into three main sections, of which the first gives the technical background, the second the practices of conservation as conditioned by scientific facts, and the third the broader engineering and social significance of the entire subject. However, the character of the papers is not entirely consistent with these artificial divisions.

Under Part I, "Water Behavior and Land-Water Relationships", there are four chapters and primary papers with able discussions of each. Chapter I, Basic Principles of Water Behavior, is by Thorndike Saville, Dean of the College of

Engineering, New York University. Chapter II, Surface Run-off Control, is by Robert E. Horton, well-known hydraulic engineer. Chapter III, Giving a Real Significance to Hydrologic Research on Small Areas, is by Merrill Bernard, Engineer of the Soil Conservation Service. Chapter IV, Influence of Vegetation on Land-Water Relationships, is by Isaiah Bowman, President of Johns Hopkins University, known to many Yale foresters and others as teacher and writer on forest physiography.

Each of these chapters will hold great interest for the forester who expects to master fully even the limited subject which we have heretofore called "forest influences". Chapter III is of special significance to those planning or executing small-scale runoff or streamflow observations. Dr. Bowman's paper will seem less "technical" because it deals, though critically, with forest, range, and agricultural problems with which foresters have more every-day contact.

Part II, "Conservation Practices Based on Land-Water Relationships", embodies nominally only five additional chapters, but Chapter VIII is an assembly of eight original papers and Chapter IX of four.

Chapter V, Management and Use of Forest and Range Lands, by Earle H. Clapp, Associate Chief of the Forest Service, is the most up-to-date treatment of the plant-water relationships that has been given "official expression" by the Forest Service, in the long series of similar treatments issued since 1928. It supplements very nicely a somewhat more scientific discussion of similar points in Dr. Bowman's paper. Although many telling examples of runoff relationships are cited, it is regrettable that the Forest Service is not yet armed with more adequate data on the flow of permanent streams, including ground-water discharge, —data which go beyond momentary, flashy runoff and bear more strongly upon the composition and performance of the larger streams, the great rivers. This lack is clearly recognized in Dr. Clapp's recommendations for future research. Veritably, so far as the forest-flood relationship is concerned, research has only scratched the surface. It is now quite generally recognized that what we conceive as "normal" topsoil is not merely an inert mass of fine or coarse particles, but is a biotic entity of which vegetation is a critical element, or, as Dr. Bowman very aptly states it, soils and vegetation are "interdependent and intercreative". But, the sub-soil is a meaningless thing to most people and even to many scientists who have "sampled" the soil with infinite patience and repetition. It is rarely thought of as a reservoir holding not only water available for plants but, possibly, a "climatic balance-wheel" on which the habitability of a land may largely depend. The phenomena of surface waters and erosion are important enough, heaven knows! But until we have explored the sub-soil conditions and ground-water supplies much farther than most current experiments go, we shall never understand forest-streamflow relations nor any other important aspect of headwaters. Foresters must master the whole subject of hydrology to speak intelligently of forest influences. To date the science has not been fully employed in our problems.

Engineers and laymen may accept at face value the many examples given of runoff control by vegetation, or the "typical" figures for surface runoff adopted by Lowdermilk of the Soil Conservation Service (p. 102) without being convinced that forests or other vegetation play an important part in major floods. These readily remembered "standards" for runoff with rains of fairly high intensity are: Forest, 2 per cent; grass, 5 per cent; close-growing grains, 25 per cent; and inter-tilled crops, 50 per cent.

In view of the fact that only the North Carolina and California studies of the Forest Service promise anything approach-

ing a complete picture of the effect of forest cover on major water supplies and stream regimen, we cannot accept Korstian's comment and suggestion (relative to Clapp's recommendations) that further extensive research in this field should be directed mainly toward the *methods* by which cover may be established and flood and erosion control may be advanced. The goal should be, first, to determine *how important* in flood-control undisturbed forest cover may be; and second, to give nature a chance to restore forest conditions, a gradual process which man cannot accelerate in any great degree, and in which the planting of trees is only a first and not too important step.

Chapter VI deals with Management and Use of Agricultural Lands, Including Farm Woods and Pastures. The paper by H. H. Bennett, Chief of the Soil Conservation Service, is discussed by six writers. Dr. Bennett's preëminence in this field can never be doubted, and to the mind of the reviewer his writings, since many years before the organization of the S.C.S. have carried an unusual degree of conviction because he is so obviously discussing facts which he has himself seen and interpreted. Probably no man in the Department of Agriculture has tramped so many miles over fields, examined critically so many soil conditions, or viewed the action of water upon soils under so many conditions as Dr. Bennett. Because he does not overestimate the importance of engineering in erosion- and stream-control, and fully believes that agricultural methods must be better adapted to the demands of nature, his comprehensive paper is by far the best-balanced picture of the situation which confronts us in the agricultural regions. There is no forester who cannot profit by knowing Bennett's thoughts.

Chapters VII and VIII, Control and Use of Small Streams and Special Aspects of Application, nine papers in all, will be found intensely interesting to the specialist, but are mainly hydrological in scope.

Chapter IX, Conservation of Wildlife, appears to the reviewer as a pleasant diversion from the problem, although, of course, a good "selling point" for all "conservation" programs.

Part III is entitled "In Larger Perspective". The papers by Morris L. Cooke of the Rural Electrification Administration, Sherman M. Woodward of the Tennessee Valley Authority, Maj. Gen. Edward M. Markham of the Army Engineers, Jacob G. Lipman, Director of the New Jersey Agricultural Experiment Station, Congressman Maury Maverick of Texas, and Charles H. Whitaker, all treat the subject in its political and human aspects. Mr. Woodward's paper, particularly, is bulging with factual matter for those who are more interested in the technical than the administrative phases of the subject. Dr. Lipmann, with the eye of the agricultural expert, envisions the broader needs of agriculture for the permanence of our well-being. His paper contains much that is informative. Not at all to be overlooked is the paper by a guest of the Conference, and official delegate of the Administration of Waters and Forests of France, M. Albert Magnein, who describes "Control and Use of Little Waters in France" in a thoroughly competent manner.

C. G. Bates,
Lake States Forest Experiment Station.

Centralized Management and Utilization Adapted to Farm Woodlands in the Northeast. By C. Edward Behre and C. R. Lockard. *67 pp. Illus. Published by The Charles Lathrop Pack Forestry Foundation and N. Y. State College of Forestry. 1937.*

In recent years much consideration has been given to the possibility of establishing working circles where raw forest prod-

ucts can be assembled, manufactured and sold at a central point. It is a well known fact that farm woodland contributes in an important way to national timber production but in many cases the individual tracts are too small to warrant a mill being set up. A central establishment might bring greater returns to the producer.

This bulletin represents the culmination of an intensive study made in connection with the organization of the Otsego Forest Products Cooperative Association and covers an area of about 700 square miles within a 15 mile radius centering on Cooperstown, N. Y. The introduction clearly states the present condition of the woodland in the Northeast and to some extent the condition of the forest industry. It explains in detail the forest utilization practices which result in forest depletion and summarizes the social and economical benefits of sustained yield and the value of centralized marketing.

Information is presented on the history of the area and its economic possibilities are analyzed. The opportunities for utilization and possible markets were given considerable study. Careful study was also given to the size and type of units needed to utilize and manufacture efficiently the raw products of the area. The report gives information on the quantity of raw material which could be produced annually on the entire area, and the machinery and equipment required to take care of this output.

The following proposals are made: Organization: Grouping of farm woodland owners into a capital stock cooperative association; Forest Management: Adoption of light selective cuttings, not to exceed the growth in any period; Utilization: Development of integrated utilization in order to market the products most efficiently.

Consideration of the social and educational significance of such a cooperative established the principle that the forest output must be oriented from the viewpoint of maintaining the natural resources rather than from that of maximum immediate profits from conversion.

The authors conclude that with sufficient forest growing stock, scientific forestry practice, adequate utilization facilities and efficient business management, the chief factor that will influence the success of a forestry cooperative is the degree to which its members understand and adhere to the basic principles of its organization and give it enthusiastic and continuous support.

R. B. PARMETER,
Extension Forester, Massachusetts

Valuation of Property. By James C. Bonbright. *1271 pp. (2 vols.) McGraw-Hill Book Co. New York. 1937. Price $12.*

Many foresters in public service or in private industry become concerned at one time or another with the necessity of determining the value of forest or related property. The property may be bare land or land with merchantable timber; it may be a sawmill, pulpmill, railroad or similar evidence of capital wealth. The appraisal may be necessary to determine the value of the property when contemplating its purchase, sale or exchange; to determine the total investment and the solvency of the industry; for price fixing or corporate reroganization; for evidence in cases of over-assessment and other taxation matters, or for other reasons. Appraisals that will conform to the legal requirements of the courts can best be made only after consideration has been given to opinions held by the courts with respect to cases involving the valuation of property similar to that in question and for a similar legal purpose, as taxation. The basic concept of value as held by academic economists and by the legal profession should be adequately understood. "Valuation of Property" is a book

well worth referring to when such problems present themselves.

The book is described as "a treatise on the appraisal of property for different legal purposes." It presents the results of a research in legal and economic theories of property valuation instituted by the author and carried on under the auspices of the Columbia University Council for Research in the Social Sciences. The author and his associates have studied several thousands of reported cases, covering practically all major issues of value theory that have arisen in American property law.

Part 1 of Vol. I relates to the concepts of economic value as developed by the economists and the courts. It includes a consideration of the problem of judicial valuation, concepts of property value, market or exchange value, value to the owner, and the concept of property as affecting the concept of value. Part 2 of Vol. I relates to estimating or proving value and describes the methods involved such as consideration of actual sales prices, actual or original costs, replacement cost, depreciation as a deduction from replacement cost new, capitalized income, and capitalized earnings. Vol. II is concerned largely with a presentation of the case studies, classified by reference to the specific legal purposes for which the valuation was made, i.e., taxation, to determine income, mortgage foreclosures, corporate reorganizations, public utility rate making, etc. This volume also includes the conclusions, case index, and subject index.

The author emphasizes that frequently the term "value" is used loosely to mean anything that one chooses it to mean, without reference to the accepted market value definition of academic economists. He states that in American law both the concept of value and the technique of its proof are decidedly influenced by the specific purpose for which the valuation is made and that the courts betray the tendency to depart from the idea of value as sale price to the idea of value as worth to the owner. The author might have made it more clear that such departures are ordinarily governed by the fact that in the cases concerned equity demands the finding of some other figure than market value. His treatment of the various "concepts" of value based on court decisions is likely to be confusing to the reader who is not well grounded in economic theory.

Of interest is that part of Vol. II which relates to the theory of social value and the technique of social appraisal although unfortunately the subject is not covered exhaustively. The author indicates, however, three major difficulties with respect to this problem. (1) The lack of relationship between money values and human values, (2) the distinction between the value of a thing to a group and the sum of its values to the individuals separately considered, and (3) the difficulty of analyzing and appraising the indirect social consequences of a proposed program of development. Controversy regarding the problem of social appraisal is between those having only a money outlook and those having only a social or indirect benefits outlook. The author states that, "One of the most promising fields for the development of concepts and measures of social value is offered by a study of proposed or realized projects such as the Panama Canal or the Tennessee Valley Authority . . ." He also might well have included as subjects of study the National and State Forests.

A. Z. Nelson,
U. S. Forest Service.

Forest Fire Insurance in the Pacific Coast States. By H. B. Shepard. *U. S. Dept. Agric. Tech. Bull. 551, 168 pp. 1937. Price 20 cents.*

This bulletin, written for foresters, underwriters, and forest land owners, includes brief elemental statements on in-

surance and timber growing. The underwriter can skip much of the section on the principles of fire insurance, but the forester and land owner will find much of interest packed in those few pages.

Then follows a comprehensive discussion of the application of these insurance principles to forests and forest fires. The determination of insurable values in merchantable timber, second growth and plantations will surprise many foresters, because these values for insurance purposes must not exceed the present market value of such property. Indeed, the reviewer believes that insurance of second growth stands and plantations cannot at this time ordinarily follow the replacement value as closely as the author indicates.

The next section points out that in the past insurance always offered coverage to new and previously uninsurable risks under the protection of high rates and usually at a time when that new business was earning relatively large profits so that it could afford to pay high premiums. In the forest business the margin of profit, of course, is usually so low that high rates would practically wipe out the demand for such insurance, as has been the case thus far. Hence this study, the first of its kind in the field of new insurance, determines a safe statistical basis before underwriting is attempted.

The study was confined largely to the Douglas fir region, the northern ponderosa pine region and the sugar pine-ponderosa pine region of California; the redwood region was not studied in detail because the mature trees are rarely killed by fire and because causative and contributive hazards there are similar to those in other regions. In the types studied it was necessary (1) to determine the extent and character of the losses; (2) to identify, evaluate, and classify hazard factors; (3) to determine values subject to loss from a single fire; and (4) to estimate the quantity of insurance that might be written at the required rating.

It was found that the normal loss expectation in the Douglas fir region is 4.7 cents per $100 of value, in the northern ponderosa pine region 11.9 cents, and in the sugar pine-ponderosa pine region 11.3 cents. On the basis of these figures and a premium income of from $150,000 to $300,000 the following average premium is suggested: Douglas fir region 50c per $100, northern ponderosa pine 40c, and sugar pine-ponderosa pine 35c. The wide spread between the normal loss expectation in the Douglas fir region and the suggested premium is explained by the tremendous conflagration hazard (the author had the benefit of the Tillamook Fire!). These are, of course, average figures; schedules are given for each region listing various charges such as protection deficiency, climatic zone, class of timber, susceptibility of species, density, topography, logging slash, brush and grassland, dead or dying timber, snags, lightning hazard, railroad, ranches and farms, lumbering, recreation zone, and automobile roads. Among the credits are listed firebreaks, railroad patrol, shut-down of logging during low relative humidity, seasonal shut-down of logging, and less hazardous equipment.

Foresters and forest landowners anxious to obtain insurance protection will probably be disappointed by the average rate and the seemingly high charges for specific hazards. Whether the suggested rates are higher than they need be could only be questioned adequately after the recomputation of the entire study and only answered by actual experience. The reviewer hazards a guess that if not too high as of 1934 when the study was completed, they will be higher than necessary as the years go by, because hazards created by or contributed to by man should generally decrease if our prevention efforts are of any avail.

The author deserves credit not only for the painstaking study but also for the development of the study technique, no small

task in itself. It is to be hoped that the bulletin will not only be read but that it may give impetus to actual underwriting, for after all the value of any investigation is dependent upon the adoption of its conclusions.

P. A. Herbert,
Michigan State College.

Estate Woodlands. Published by the Royal English Forestry Society (R. C. B. Gardner, Secretary), with a foreword by the Duke of Buccleuch. *London. 1937. Price 1s.*

This bulletin sketches the treatment required to place neglected English woodlands of different types in productive condition, and shows how some of the obstacles to forestry practice are more apparent than real. It deals more with broad general principles than with the technique of individual forest operations, and refers landowners to men with specialized training and experience for the actual conduct of the work.

Apparently the only conflict between game management and good forest management in Britain is the rabbit population. Rabbits have become such a pest that some landowners must expend 15s. or more per chain for fencing to exclude them from areas to be regenerated.

One sentence in the section devoted to amenity is worth repeating: "It is a mistake to think, as so many people apparently do, that the trained and professional forester has no eye for beauty; nor must it be assumed that amenity woods are necessarily in a class apart in woodland politics."

The section devoted to the marketing of forest products contains a number of very constructive ideas.

T. E. Shaw,
Purdue University.

Flood Control. *80 pp. American Forestry Association, Washington, D. C. 1937. Free.*

In order to focus attention on floods as one of the country's most perplexing conservation problems, the 62nd annual meeting of the American Forestry Association was held jointly with the Ohio Forestry Association in Cincinnati May 31-June 3 of this year. Devoted to the subject of water conservation and flood control, the meeting was notable for bringing together the forestry, engineering, soil conservation, agricultural, industrial, and legislative viewpoints.

This brief but comprehensive publication includes the numerous papers presented at the meeting. In reading them one is convinced that the problems of flood control and water conservation are not to be solved by engineers, foresters, or soil conservationists working independently. As a matter of fact, the representatives of these professions whose papers are published herein emphasize that the attack on flood control must be a concerted one, with all agencies contributing their quotas of technical knowledge and skill.

In addition to the key-note statement by James G. K. McClure, Jr., President of the American Forestry Association, there are eleven informative papers by outstanding authorities. The legislative viewpoint is discussed by Hon. William M. Whittington, Chairman of the House Committee on Flood Control. The foresters' viewpoints are stated by Edmund Secrest, State Forester of Ohio, Dean Graves of the Yale Forest School, and C. L. Forsling of the U. S. Forest Service. The engineers' viewpoints are presented by Gen. Max C. Tyler and Col. Dabney Elliott of the U. S. Army Engineers, Sherman M. Woodward of the Tennessee Valley Authority, and C. H. Eiffert of the Miami Conservancy District. The soil conservation viewpoint is outlined by W. C. Lowdermilk of the U. S. Soil Conser-

vation Service; agriculture's by Secretary Henry A. Wallace, and industry's by Dr. Wilson Compton.

In a word, this interesting publication brings together for public consideration several viewpoints which twenty years ago would have been divergent in the extreme, but which today are happily harmonized and integrated. It affords a glance into the future when water conservation and flood control will be no longer a hope but a reality.

HENRY CLEPPER.

Die Vorratswirtschaft. Erster Teil. Die Waldbautechnik der grössten Wertleistung. By Konrad Rubner. *x + 115 pp. J. Neumann, Neudamm and Berlin. 1936. Price 6.50 RM.*

Curiously, at almost the same time that American foresters were attempting, through the forest industry codes, to bring about the substitution of partial cutting for extensive clear cutting, a movement with similar objectives was on foot in Germany. There, clear cutting followed usually by artificial regeneration had long been the rule in a large part of the public as well as the private forests, particularly the pine forests. A few individuals—and these were mainly private timberland owners—had demonstrated to their own satisfaction that partial cutting and continuous maintenance of a forest cover, with very small clearings or none at all, gave better yields even in pure forests of Scotch pine. Their views were not accepted, however, by the majority of the leaders in the forestry profession, at least in northern Germany.

The political revolution of 1933 brought with it a revolution in forest management. First, it was decreed that henceforth the standard form of management in the state forests of Prussia should be some form of partial cutting. This was soon followed by the "forest devastation law", which practically forbade clear cutting of any considerable area in any public or private forest in the entire Reich. The emphasis has now shifted from seeking the maximum immediate profit in harvesting the timber crop to the development and maintenance of the optimum soil conditions and the optimum growing stock—which, of course, is expected to bring the greatest return to the national economy in the long run. This is what is meant by *Vorratswirtschaft*—literally, growing stock management. Concentrated cutting and regeneration are giving way to single-tree cutting, major dependence is placed on natural regeneration, and more attention than hitherto is being given to improvement cuttings, thinnings, and other silvicultural measures tending to improve the quality of the growing stock and hence the ultimate yields. The tendency is to place at least as much emphasis on quality as on quantity of timber. These changes necessitate radical changes in methods of regulating the cut, and a reorientation of silvicultural practices.

Rubner's work aims to set forth the silvicultural principles and practices that will best accomplish the desired objectives. The second part, dealing with regulation and management, by Dr. Franz Heske, is to come later. As the authors say, no new discoveries in silviculture or forest management are involved. It is rather a question of shift in emphasis and application of methods and principles already known and to some extent, at least, proven in actual practice. They clearly recognize that it is necessary to deal with the forests as they are, not with the ideal forests such as may result after a century of growing stock management. Changes must be gradual, so that the best features of the old methods may be harmonized with the new.

Rubner brings out clearly that silvicultural practices will have to be adapted to the individual stands, hence no one need

fear the bugaboo of uniformity and standardized silviculture. A selection system will be ideal for forests in the high mountains and for stands composed entirely of tolerant species elsewhere; for tolerant and semi-tolerant species groupwise management with careful tending of the growing stock and long regeneration periods will generally be best; and for intolerant species preference should usually be given to shelterwood-like systems, with the overwood in groups and with fairly short regeneration periods.

This book can be heartily recommended to those interested in the present-day trends of German silviculture.

W. N. SPARHAWK.

The Utilization of Sawmill Waste and Sawdust for Fuel. By J. L. Jenkins and F. W. Guernsey. *Dept. of Mines and Resources, Canada. Forest Service Circ. 48. 15 pp., 3 pls. 1937.*

In certain parts of British Columbia the sale and distribution of mill waste and sawdust for fuel is an organized business of growing importance. This applies particularly to sawmills close to large towns or on navigable waters. The story is somewhat similar to that of our northwestern states. Hogged mill waste and sawdust are sold to industrial plants, particularly pulp mills, and to dwelling houses, apartments, hotels, and theaters. For domestic heating, approximately 15,000 sawdust burners are used in Vancouver and vicinity alone. This is, of course, only a fraction of the number of similar burners used in the United States.

Burners of this type are reported to deliver a steady heat, to be easily controlled, and to be economical in operation. The cost of heating a five-room house in Vancouver is approximately $35 for a winter. Some trouble has been experienced with the corrosion of domestic boilers, particularly the hot-water type, largely because of failure to drain boilers and to clean combustion chambers and flues properly in summer. Hot-air furnaces burning sawdust have experienced no such difficulties.

Although sawdust is bulky to store and handle, the authors place more faith in its use in bulk than in briquette form. They may be correct in this estimate of the situation; nevertheless, the production in 1935 of 43,500 tons of briquettes for cooking and open fireplaces in the western part of the United States can hardly be considered insignificant. Material for briquettes must, of course, first be dried, whereas hogged mill waste and sawdust can be burned green from the saw.

The volume and weight of wood fuel and the heat value of wood and sawdust for Douglas fir, western hemlock, western red cedar, and Sitka spruce, based on tests at the Vancouver laboratory, are presented in tabular form. This information is applicable in our own Northwest.

The circular stimulates a desire to utilize mill waste and sawdust to even better advantage, not only on the West Coast but elsewhere; to find cheaper means of getting it from production centers, where it is abundant, to consuming centers where it is in great demand; and to continue with improvements in various types of burners.

JOHN B. CUNO,
Forest Products Laboratory.

CORRESPONDENCE

Dear Professor Chapman:

Mr. Holdridge's letter to you regarding the lack of appeal of the Journal, published in the July issue, struck a very sympathetic chord when I read it.

In an attempt to throw further light on the present value of the Journal to its readers I herewith submit a brief summary of articles printed versus the articles that I have read for the past twelve months, from July 1936 to June 1937, inclusive.

Type	*No. printed*	*No. read*
Editorials	11	11
Major articles	162	60
Briefer articles and notes	72	38
Reviews	58	32
Correspondence	19	19
Totals	332	160

This summary is in quite close agreement with Mr. Holdridge in that the technical articles run in the Journal are of interest only to technically inclined men, or to foresters who happen to be individually concerned with the particular problem.

As you will note the Editorials and Correspondence rated one hundred per cent readable. The reason is because they dealt with interesting, purposeful subject matters, such as policies or opinions on all phases of forest work and education. These subjects are vitally interesting, I believe, to practically every forester, regardless of his age, branch or length of service.

Among the major Articles the ones which commanded interest were those dealing with subjects similar to the preceding, subjects of universal import to American foresters. Of course when an article was published which dealt with a local situation or a phase of technical forestry with which I happened at the time to be concerned then I read it, but the majority of the articles not read were either technical or had to do with individual problems far removed from my present sphere of forestry.

In general the same might be said for the Briefer Articles and Notes.

As for the Reviews, although I cannot say I read them all, I am of the opinion that the review section is a very necessary adjunct of the Journal. From this section it is possible to glean information which in any other manner would be very difficult indeed to obtain. I do believe, however, that even in it there is some room for improvement. Books which have to do with matters of policy or opinion would be more impartially served, as would the readers of the Journal, were there to be printed two or three reviews of each publication, written by men with different outlooks and varying points of view. Technical and factual reviews, of course, require no change in the present manner of reviewing.

Now for a comment on the final section of the Journal, Correspondence. There is altogether too little of it. Whether this is because more correspondence is not received from Journal readers, or because it is not submitted for publication I don't know. At any rate the correspondence that does find its way to the printer deals with subjects of universal interest and presents variable viewpoints and very

often healthy, vigorous differences of opinion, all of which are a stimulus to the Society and to foresters in general.

My outlook is that of a young forester keenly interested in forestry and the Society, and in keeping abreast of things new. Highly technical problems do not, generally speaking, interest me or have any immediate effect upon my work. From my constant associations with the younger men in forestry, and my everyday observations of their interests, I believe that I represent a fair average of that field. For the others I am obviously not qualified to speak, as naturally my contacts have been distinctly limited.

Could some definite steps not be taken to induce more contributions to the JOURNAL, especially from the foresters who are not in the habit of submitting their opinions to its columns? Would it not be advantageous to add to the JOURNAL another section edited for the express purpose of drawing contributions and ideas from the general run of practicing foresters? My recommendation, for the sake of starting the ball rolling, would be for the JOURNAL to present each month a thought-provoking but perhaps somewhat opinionated article on some current matter of vital concern to forestry. It should be written in such a manner as to arouse an opinion on the part of the reader, and the section should definitely state that its purpose is to print, each month, a selection of opinions received from its readers. Admittedly this would mean more work on the part of someone connected with the staff, or else selection of another individual to handle the new section, but would it not more than repay the extra effort required?

Naturally contributions would at first be somewhat difficult to obtain, and the new section would demand careful nursing along with vigorous stimulation to insure its sound development. Once under way, however, the other sections of the JOURNAL should also benefit from the increased "contributary mindedness" of its readers, and the entire field of forestry would in turn gain much that it lacks at present.

Although the suggestions within this letter may not in themselves be of practical value, perhaps Mr. Holdridge's letter and mine will incite further thinking on the part of JOURNAL readers to the end that eventually the JOURNAL will become a much larger contribution to forestry than it is at present.

WILLIAM S. MEACHEM.

DEAR SCHMITZ:

Enclosed find a letter from William S. Meachem, dealing with the subject of JOURNAL contents.

It has been obvious to me for some time that the JOURNAL is attempting to fill a dual role. Since it is the only publication of the professional Society, it cannot ignore the field of technical advancement any more than could medical or law journals. As a matter of fact the latter concentrate almost exclusively on technical subjects. On the other hand forestry is far more than a technical field—to a far greater extent than medicine, law, or engineering. The interest of a large majority of our members, especially of the younger men, lies along lines of popular rather than technical subjects.

It has been the constant effort of the editors of the JOURNAL to give in each number a balanced program in which both of these fields are covered. The fact that there are technical articles in the narrower fields ought not in itself lower the value or interest of the JOURNAL to the average reader provided there is sufficient material along popular or economic lines to make him think that each number is worth reading. Very few of our members would be interested in the entire contents of any issue.

I do believe that the contents can be apportioned to meet the sentiments of the larger number of the younger men with-

out sacrificing the high plane of excellence in the technical field.

The Swedish Forestry Society has met this situation by publishing two separate magazines. In the technical publication such articles as would appear in the *Journal of Agricultural Research* (as well as in the Journal of Forestry) form the subject matter; in the other publication the contents is entirely devoted to popular discussions.

I have long felt that this might be the ultimate solution of our problem. Its present solution along this line is impossible and will be as long as our members pay dues which amount to about one-fourth of those of other professional societies. We have the number to support two such magazines but the members have not yet appreciated the scope of the functioning of the Society to the extent of being willing to pay for services performed, or capable of being performed.

I am sending a copy of this letter to Mr. Meachem and presume that you will wish to correspond with him.

H. H. Chapman.

Executive Secretary,
Society of American Foresters,
Dear Sir:

On page 701 of the July Journal of Forestry, L. R. Holdridge has said what a number of members of the Society have thought for several years; that by and large, the material printed in the Journal is not read by the average member.

For several years the writer thought perhaps he was alone in this view. Then I inquired around and found that the Journal was not being read as it should be read. And since receiving the July number I have made it a point to ask a number of the younger members just how much of the Journal they read, and I find that Mr. Holdridge is right, those I talked with do not read but a fraction of the material. Their school days are over and they are not interested in the class of material that is useful to only a fraction of the membership.

Please do not think this a criticism of the fine job that has been done by the editors. Some mighty interesting articles appear in the Journal. But there is a lot that does not interest the forester who is up against the big administrative problems of federal or private forestry. In other words, after 35 years' experience in trying to help put across the need of a real conservation program in America, I am convinced that there are many more important forestry subjects that might appear in the Journal than some of the clearly sectional and "schoolmaster" type that now appear.

If you ever take a membership vote on this you will find that Mr. Holdridge is right.

L. A. Barrett.

Dear Mr. Barrett:

Any one concerned with the welfare of the Journal of Forestry, whether in an official capacity or not, could hardly be otherwise than impressed by the sincerity of Mr. Holdridge's letter in the July issue and by your additional comments of July 14. Such criticism is constructive and helpful, and I am sure I speak for the entire editorial staff when I say it is very welcome.

The question is: what to do about it? By and large, foresters in teaching and research fields, though numerically a minority in the Society membership, are faithful contributors to the Journal. It follows that, because of the nature of their work, their contributions frequently reflect their interests in being highly technical and, consequently, somewhat limited in general interest. Nevertheless, such contributions, based on sound scientific investigation and logical inference, are the back-bone of any publication with scientific pretensions.

On the other hand, the necessity exists, as you and Mr. Holdridge have pointed

out, of publishing articles of general interest—articles, in short, of an informative or administrative nature. Let's examine the July issue, in which Mr. Holdridge's letter appeared, to see how many articles are of general, and how many of strictly limited, interest. That issue contains 15 longer articles including the editorial; 12 might be classed as general interest papers and only 3 of limited interest. What would be your analysis of the issue? Similarly, my estimate of the June issue which contains 15 longer articles, would be 10 of general, and 5 of limited, interest.

Whether we might agree on this analysis is beside the point; what we are in agreement on is the desirability of publishing an official magazine that will most adequately serve the needs of the profession. It has been my belief that the JOURNAL for some time past contained a fairly reasonable balance of general and limited-interest articles, with the balance slightly in favor of the general articles.

Dr. Schmitz, the editor-in-chief, has gone on record numerous times, since taking over the editorship of the JOURNAL last April, in inviting contributions from all fields within the profession, and particularly from the younger men. One thing we can be sure of: he will not favor one class of writer or practitioner over another; and any article, from whatever source submitted, that has something to say and says it in an acceptable manner, will receive favorable consideration.

Just one thing more: will you be good enough to scrutinize subsequent issues of the JOURNAL and let me know which articles fall within the class of those that you believe are particularly acceptable to the body of readers for whom you speak?

HENRY CLEPPER.

DEAR PROFESSOR CHAPMAN:

I have read with much interest L. R. Holdridge's letter to you suggesting certain changes in the subject matter of the JOURNAL OF FORESTRY which, in his opinion, would make the JOURNAL of considerably greater interest to the *average* Society member.

I must say that I am in hearty accord with Mr. Holdridge's views in this matter, and sincerely hope that his suggestions will be given serious consideration by the editorial staff or those who have the responsibility for selection of the subject matter.

Unlike Mr. Holdridge, however, I do manage to "wade" through practically every issue, but I do this more because of the feeling that it is my "professional duty" to do so than from any real or genuine interest in a great many of the articles which, like Mr. Holdridge, I feel are more suitable for a technical or research publication.

Allow me to say in conclusion that I am by no means attempting to discredit the splendid work of Mr. Smith or his editorial staff, but I do feel that by a few changes along the lines suggested by Mr. Holdridge the JOURNAL would become of greater service and enjoyment to the membership.

CHAS. W. NUITE,
Resettlement Administration.

DEAR MR. PRATT:

The members of the California Redwood Association are in hearty accord with the principles set up by foresters for the protection of forest lands and with the objectives of yourself and your division. They recognize the public interest as well as their personal interest in leaving logged lands in a condition favorable to regrowth in order to provide for a future supply of timber and along with it permanent industries and employment. They are convinced from experiences of the past that the success of the selective logging forestry program is jeopardized if fires are not kept out of cutover lands. As you are already aware, we are now well launched into this pro-

gram and that under it we are leaving, for future growth and for seed trees, a number of immature and other trees. Under the traditional methods these trees were destroyed. In order to protect these "reserve" trees it is necessary, after slash has been disposed of and the logged land has been put in proper condition for natural reseeding, that they and the anticipated crop of seedlings be protected from injury or destruction by fire.

We have already begun a program of careful slash disposal and we wish now to further improve our protection effort. In this we need your support and that of the general public. For your information we propose to do the following:[1]

1. Members of the Association will dispose of slash by means of fire only at seasons when burning is effective and safe. Effort will be made to burn all slash between the time of the first soaking rains in the fall and the following May 15. No slash will be set afire in the period between May 15 and the first soaking rains of autumn unless weather conditions are safe for burning.

2. No fires will be set between May 15 and the time of the first soaking rains (or in any event before October 15) without obtaining a permit in writing for such burning from the State Forester or his designated representative.

3. Slash will be burned in small units rather than broadcast over large areas. On sloping ground fires will be set from the top downward and no fire will be set below the topmost one until the latter has burned out sufficiently to be under control.

4. Slash burning will be so controlled as to do a minimum of damage to seed trees and other trees reserved for future growth in so far as operating conditions make it feasible.

5. Snags which catch fire and which, because of location, may spread fire to other areas not ready for burning, or in a virgin or reforesting state, will be cut down or patrolled until the fire is out.

6. Each operator will have a suitable supply of forest fire fighting tools at each landing and at each camp. The number and kind of tools will be designated by the C.R.A. forester and will be based upon the number of men at each landing or camp, the location hazards and other pertinent conditions. Tools will be suitably marked as being for fire fighting only and will be kept in red painted boxes conveniently located and sealed with a car seal or its equivalent. The tool boxes will be inspected at frequent intervals for number, type and condition of tools by the C.R.A. forester.

7. On areas where stream logging is being practiced prior to slash burning ("logging in the slash"), steel drums, pails, or back-pack pumps full of water will be set up along the general direction of the logging lines, where no natural supplies of water are available.

8. Whenever, in tractor operations, conditions warrant it, pails, drums, or back-pack pumps full of water will be maintained away from the landings and near the tractor turning points.

9. Each operator will instruct all his employees to be on the alert for fire at all times; to report fires without delay to the company's designated fire officer, and, pending arrival of a fire fighting crew, to do everything possible to keep the fire under control.

10. The C.R.A. will keep in touch with the U. S. Weather Bureau during the fire season for reports of approaching "fire weather" conditions and will take the necessary steps to broadcast the information to the operating companies.

11. Each operator, upon learning of fires burning outside his own property,

[1]Editor's Note: These proposals have been accepted by the State Board of Forestry and are now in operation.

and apparently unwatched, will report them to the owner of the property or agent and to the local state forest ranger. Fires burning on property of operators will be similarly reported to the local state forest ranger.

12. The C.R.A., and each operator independently, will cooperate to further fire protection efforts through building up local sentiment against uncontrolled or unauthorized burning.

13. Each operator will designate a specific person to be in charge of all activities incidental to the prevention or suppression of fires under some such title as fire ranger, fire chief, or its equivalent. This may be the logging superintendent, camp boss, or, on the larger operations, a man specially employed for this function. It will be the duty of the fire ranger to organize woods personnel for effective functioning in the detection and suppression of fires and to see that fire fighting equipment is always in readiness.

14. Each company, by some means adapted to local conditions will let it be known to adjoining property owners that it means to enforce its fire exclusion policy and will endeavor to get their cooperation through friendly sentiment and the cleanup of hazards.

15. Inasmuch as public sentiment concerning burning in the redwoods is such as to favor frequent burning of all forested or reforested lands, and inasmuch as the experience fo 1936 points directly to public sentiment favoring burning as the cause in large part of the multiplicity of fires in 1936, the C.R.A. through its forester and in other suitable ways will endeavor to set forth to the public the danger of uncontrolled burning and the loss to the community occasioned thereby.

16. An attempt will be made also by the C.R.A. forester to contact local justices of the peace and obtain their support in the enforcement of laws concerning incendiarism.

17. The C.R.A., through its forester, will also contact nonmember operators, whether loggers or split products producers, to obtain the understanding on the part of this group of the reasons for this agreement, and further, to obtain their friendly cooperation in undertaking like preventive, detection, and suppression measures.

May we ask that you undertake the following in furtherance of the protection program:

1. The strengthening of the field force by adding overhead supervision in charge of fire prevention, detection, and suppression in the redwood region;

2. Raising the effectiveness of the field force in combatting fire problems;

3. Obtaining better cooperation on the part of stockmen, ranchers, and the general public;

4. Adding to, or otherwise improving the effectiveness of the state's inspection and law enforcement staff for running down causes of surprise fires and the apprehension and correction of incendiaries;

5. Scrutinizing newspaper releases concerning active fires to see that they are correct;

6. Giving whatever aid is possible to ranchers and stockmen to assure the burning of their brush lands with safety to surrounding property;

7. In any other way improving the public attitude toward fire and to fire exclusion except for legitimate purposes.

8. Delete from the present burning permit form the reference to liability.

C. W. Bahr, *President,*
California Redwood Association.